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Editorial Contents for August, 1930

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Duryea Cushion Underframe on Nearly 10,000 Cars ..... **Page 441**

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Gas-Electric Rail-Car Maintenance on the Reading ..... **Page 454**

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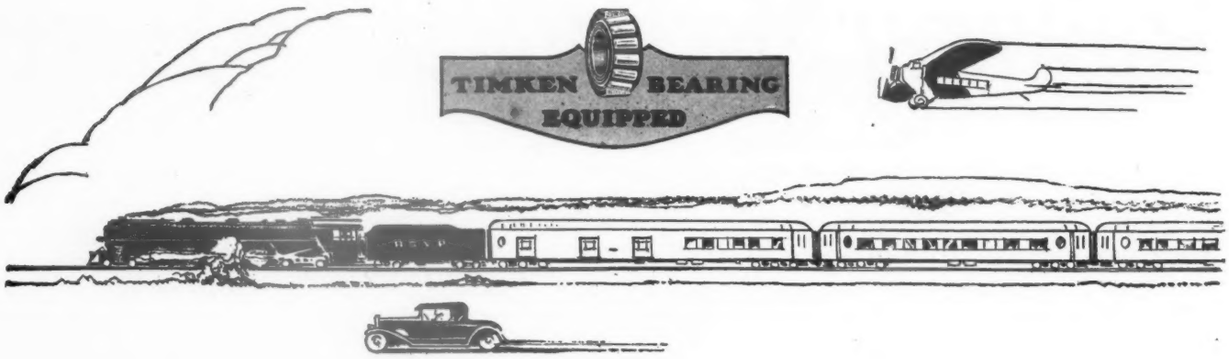

Railroad Trains *and* Race Horses

Trains struggling against friction are like horses carrying too much weight in a race—hopelessly handicapped.

And railroading today *is* a race . . . a race against time—and newer methods of transportation.

Keen railroading brains long ago recognized the problem and sensed the solution—heavier trains, faster schedules, lengthened non-stop runs, indisputable dependability, increased "on time" percentages.

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TIMKEN *Tapered Roller* **BEARINGS**

Railway
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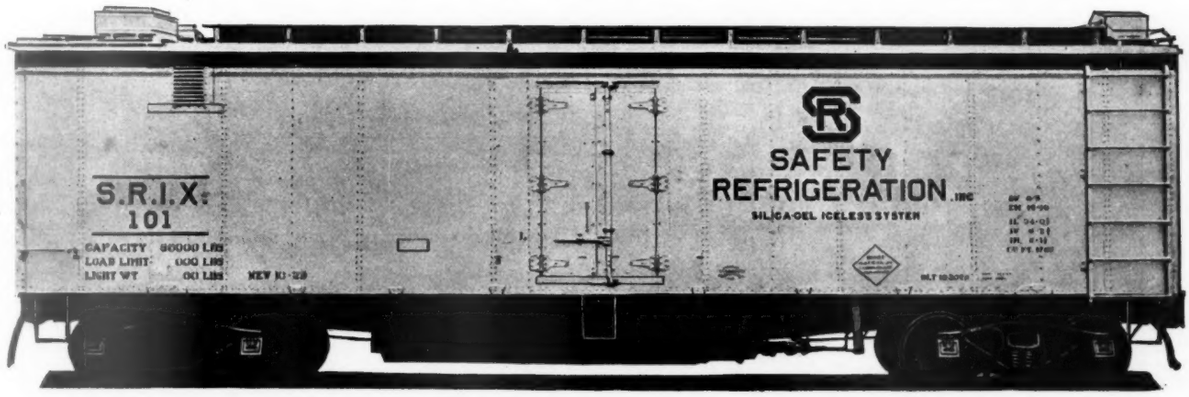
Founded in 1832 as the American Rail-Road Journal

August, 1930



One of the all-steel Silica Gel refrigerator cars

All-Steel Iceless Refrigerator Car

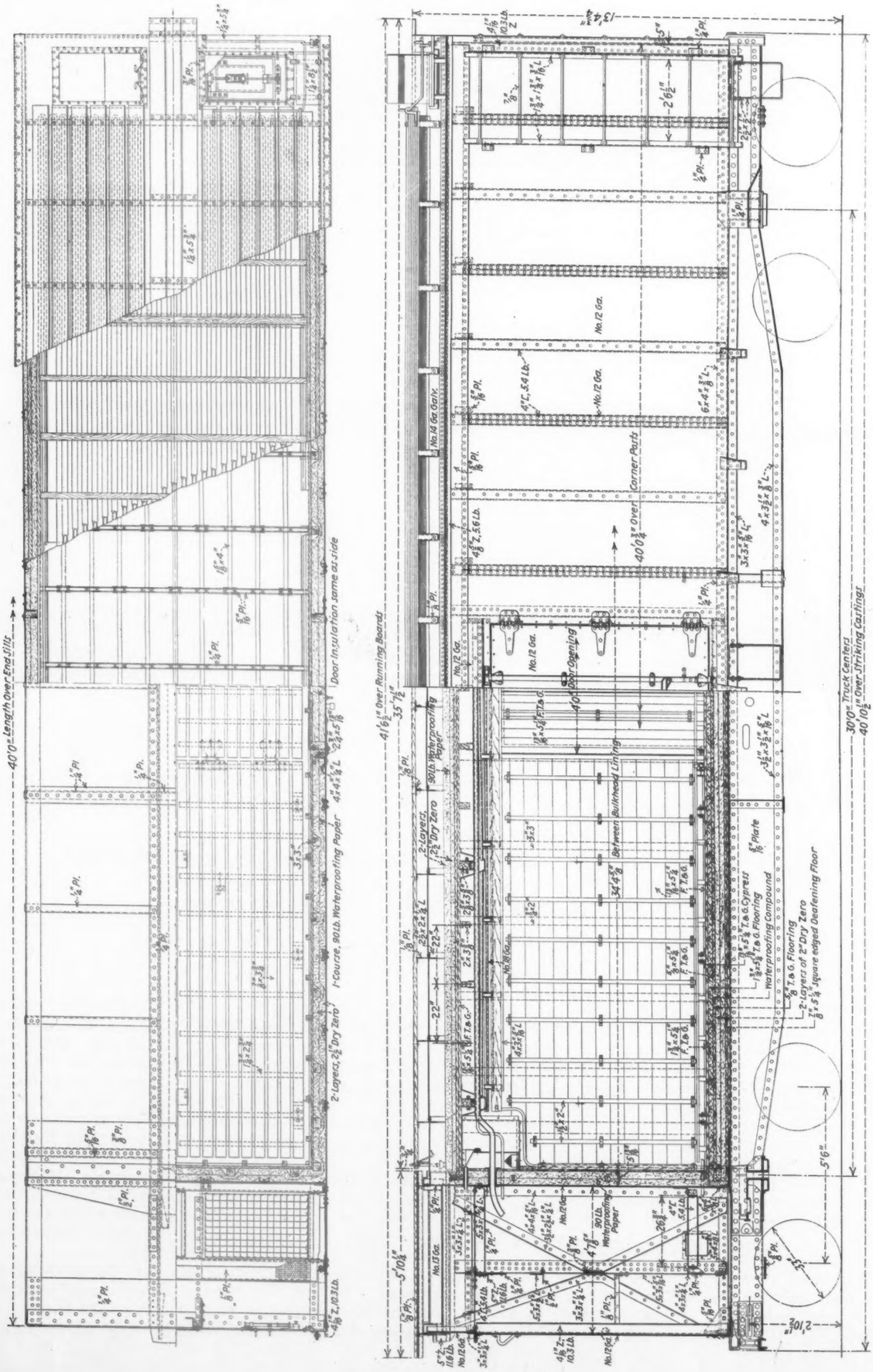
Equipped with improved thermostat control and heating system—Car tested by U. S. Department of Agriculture

SAFETY Refrigeration, Inc., a subsidiary of the Safety Car Heating & Lighting Company, New York, recently placed in service 50 silica gel refrigerator cars of all-steel construction that are equipped with an automatic heating system and with an improved type of thermostat control mechanism that is controlled both by the outside temperature and the temperature inside the car itself. The application of the automatic heating system and the improvements in the control mechanism make possible the transportation of perishable commodities at any temperature, irrespective of outside weather conditions.

The Car Construction

The car is of steel construction throughout, except for the floor and the inside lining and its supporting posts. A steel underframe is used consisting of a deep fish-belly center sill with steel cross-bearers and bolsters and side sills of 5-in. by 3-in. angles. Corner posts of angles at the B end and Z-bars at the A end are used, the flanges of the latter being used as a means of bolting the A end (which is removable) in place. The sides are constructed of No. 12 gage sheet steel, these sheets being 56 in. wide and continuous from side sill to side plate. Vertical 4-in. channels are riveted to the inner surface of these sheets at 28-in. intervals. The joints between the sheets are made at channels and a splice plate is applied to the outside at these locations. The side sheets and channels are riveted to the side sill at the bottom and to a 5/16-in. side plate at the top. This plate is of angular section with the flange projecting outward at the top of the side, to which the roof is riveted. The ends are of the same construction except that diagonal bracing is added.

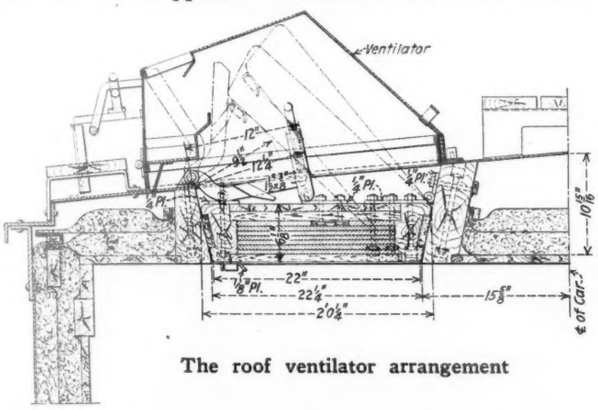
The compartment for the silica gel refrigerating apparatus is built in the A end. With this arrangement the insulated portion of the car body starts about 5 ft. from the A end sheet. In order to facilitate the installation of the apparatus the A end sheet and the roof over this compartment have been designed so as to be



Elevation and plan drawings of the Silica Gel all-steel refrigerator car

readily removable. The apparatus is supported in this compartment by framing which forms a part of the car structure.

The floor consists of 7/8-in. boards laid transversely and carried on the side-sill angles and the center sill. On this are laid the two insulation blankets. Wood sills at the sides are then applied, being secured to the side channels but spaced from them by means of steel brackets and supported at intervals on wood blocks.



The roof ventilator arrangement

This construction permits the application of a good amount of insulation at the side sill. A wood stringer is also placed over the center sill and this is likewise supported at intervals on blocks. Upon this stringer and the wood sills 5/8-in. tongue and groove boards are laid across the car and 1¼ in. of waterproofing compound is spread over course. The 1¾-in. main floor is next applied, the boards being laid transverse of the body and supported on the wood side sills at their ends and by the stringer at the middle. A top floor of 13/16-in. cypress is then laid with the boards running longitudinally.

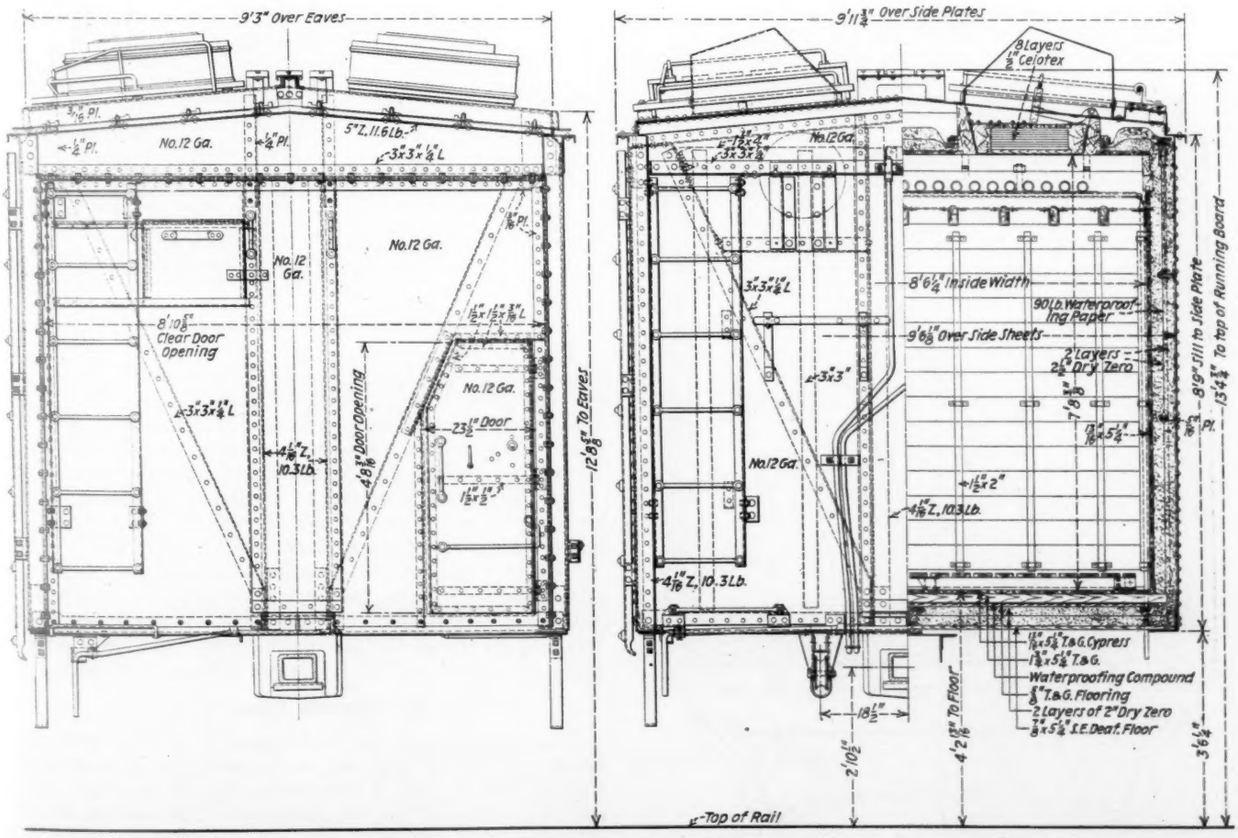
In the side-wall construction, a wood plate 1-½ in. by 6 in. is secured at the top of the side sheet by steel brackets riveted at the upright channels and spaced away from the side sheet to permit the application of insulation. Vertical 3-in. by 3-in. posts, carrying the inside lining and spaced midway between the channels, are bolted to the plate at the top and tenoned into the wood sill at the bottom. This construction affords a minimum direct contact between the outside and the lining. Two 2-½-in. insulating blankets are applied between the inside lining and the side sheet, being supported from the top and at intermediate points. These blankets are continuous from door to door.

The ceiling is laid on transverse rafters supported by the lining posts and two 2-½-in. insulating blankets are spread upon the ceiling. The edges of these blankets are sewed to the upper edge of the side-wall blankets, thus providing continuous insulation at the eaves.

The roof of the car is made of No. 14 galvanized iron riveted to pressed carlines and provided with a Z-bar at the eaves. This roof is assembled as a unit and applied to the car body after the ceiling and insulation is in place. It is secured to the car body by rivets through the Z-bar and the outstanding leg of the side plate.

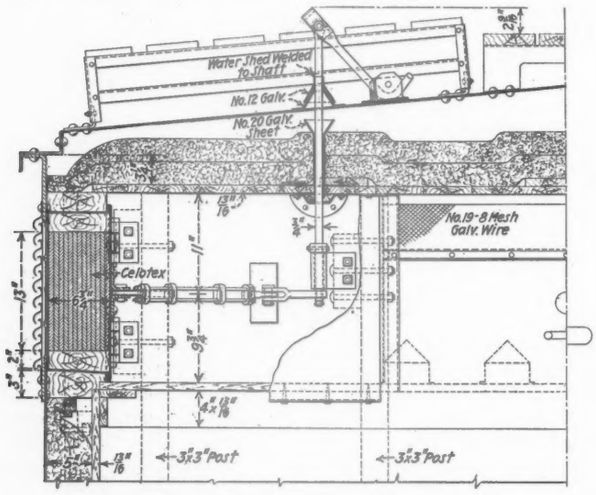
The Heating and Refrigerating Systems

The heating system consists of a radiating coil placed under the floor racks of the car and connected to a heating coil placed in the adsorber compartment.



Sectional elevations of the ends of the car

This coil is heated by the same fuel which operates the refrigerating system, the operation of the burner being controlled by a thermostat. The heating system is filled with liquid which will not be affected by low temperatures. To prevent heat leakage into the refrigerating compartment from the heating system when it is not

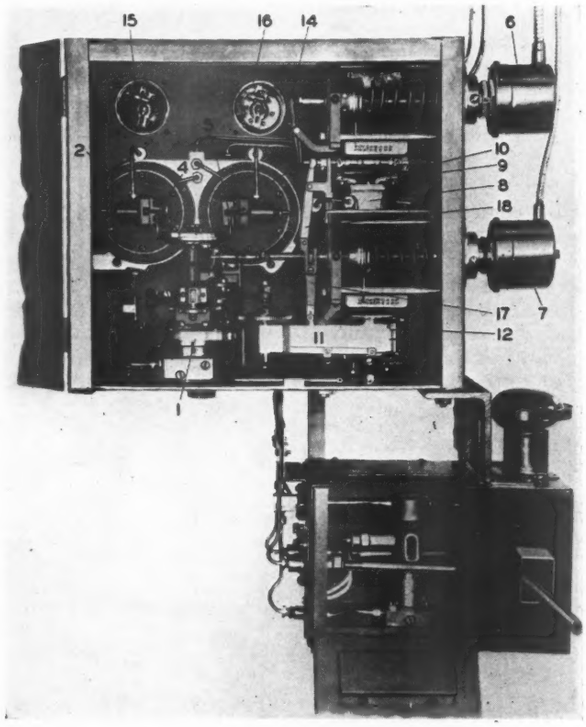


Sectional elevation of the side ventilator

in use, a valve is placed in the fluid line so that no flow of the heated fluid can take place. This valve is interlocked with the heater burner so that the burner cannot be turned on during the period when the fluid valve is closed.

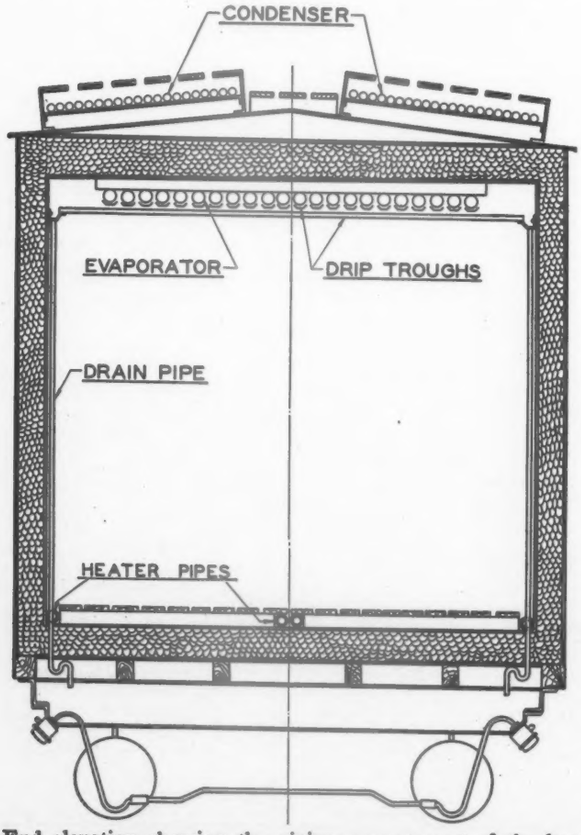
The silica gel refrigeration system is identically the same as described in the *Railway Mechanical Engineer* for March, 1928. It consists essentially of three main parts; namely, the adsorber (containing the silica gel), an evaporator and a condenser, and may be briefly described as being identical to a compression type machine with the compresser replaced by the adsorber, the adsorption of the refrigerant vapor by the silica gel corresponding to the suction stroke of the compresser and the activation of the silica gel to the discharge stroke.

The application of the system is shown in one of the illustrations. The evaporator, consisting of a series of parallel pipes running longitudinally in the car and connected to a transverse header, contains liquid sulphur dioxide. It is suspended close to the ceiling of the car. The condenser is of the air-cooled type and consists of a series of pipes mounted on the roof of the car and protected from the direct rays of the sun by a



The thermostat control apparatus

cover. The two sections of the adsorber are placed at one end of the car outside the insulated car body. The groups of vertical tubes containing the silica gel are placed in insulated fireproof casings provided at the top with ventilators to give a rapid upward movement of air and of the products of combustion from the gas burners. The burners which furnish the heat for activating the silica gel are placed below the tubes. The operation of the system is effected entirely by lighting and extinguishing the burners alternately at the proper interval. The period of heating is of about 30 minutes' duration and the interval between successive heating periods is about 2½ hours for normal operation.



End elevation showing the piping arrangement of the heating and refrigerating systems

Thermostat Control

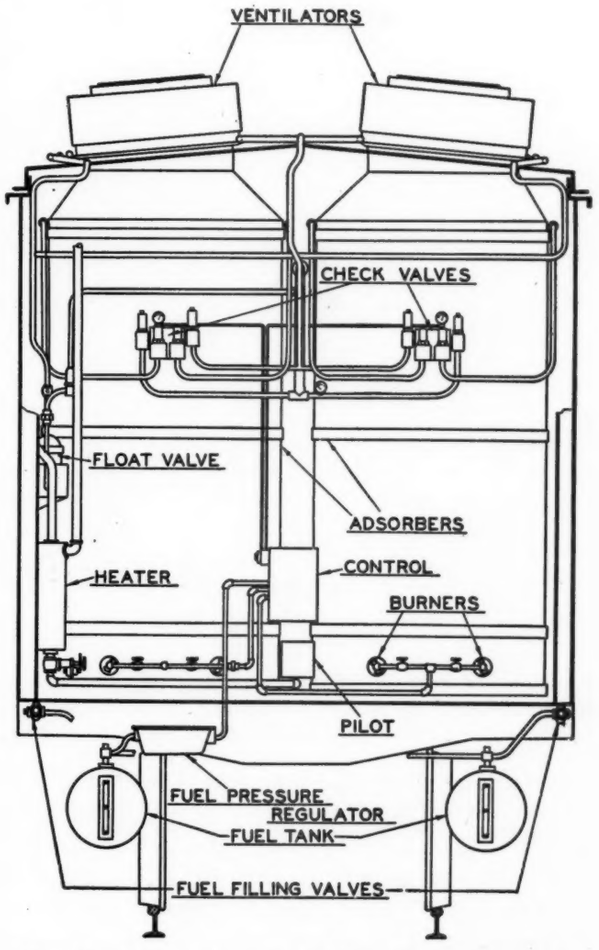
The operation of the refrigeration system and the heating system is regulated by an improved type of control mechanism that is installed in the 50 new cars, and shown in one of the illustrations. The operation of the system is timed by a gas motor *1* actuated by a small flow of fuel gas. This motor is a flexible diaphragm

which is given a reciprocating motion by the gas pressure by means of valves actuated by the movement of the diaphragm. The diaphragm makes a cycle of two strokes in two minutes. This reciprocating motion is transformed to a rotary movement by suitable gearing to revolve the cam disc *19* once in five hours. On this disc is a cam which opens a relay gas valve *4* or *5* which supplies pressure to the diaphragm of a main gas valve *2* or *3*, opening the valve and allowing gas to flow to the proper burner. The cam holds the main valve open for the proper activation period after which the relay valve closes and pressure is released from the main valve which closes, extinguishing the flame. The car temperature is controlled by a thermostat, having a container for a volatile liquid located in the car, connected by flexible tubing to the power element, a metallic bellows *7* at the control.

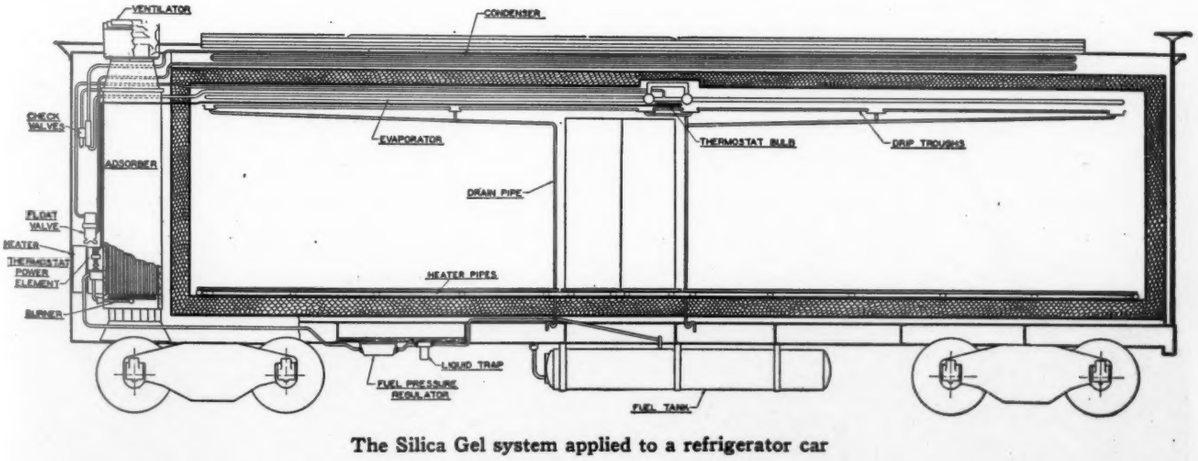
If the car temperature is above normal the system operates at its maximum speed, that is, each adsorber is activated for forty minutes in each five-hour interval and adsorbs for four hours, about twenty minutes being required for cooling after activation. When the operation of the system has brought the car temperature below normal the thermostat acts to stop refrigeration until the temperature is normal again.

When the car temperature is below normal the contraction of the bellows *7* disconnects the clock *1* from the cam disc *19* so that while the clock continues to run the cam disc remains stationary and does not move again until a rise in the car temperature connects the clock to the disc. The arrangement is such that the cam disc cannot be stopped while an activation period is in progress.

If it is desired to protect the contents of the car against cold as well as heat, the gas valve to the heater is opened and its pilot light put in operation. The heater-control thermostat *6* is set for the outside temperature at which heating is to be available. At temperatures above this, the cooling system performs in its normal manner. When the temperature outside falls to that for which the thermostat *6* is set the contraction of the bellows moves the lower end of the lever *14* to the left, closing the valve *9*. This valve supplies pressure to the controls for the cooling system and, when the valve is closed, the cooling system cannot operate. If the car temperature does not go below normal, neither cooling nor heating is supplied. When the car temperature goes below normal, the bellows of the car thermostat contracts, moving the upper end of lever *18* to the left and closing the heater supply valve *19* which admits gas to the heater burner. When the heat supplied by the heater has brought the car temperature up to normal the bellows expands, moving the top of lever *18* to the left and closing the heater supply valve. The heating equipment remains in operation controlled by the car thermostat until the outside temperature rises above that for which the thermostat *6*



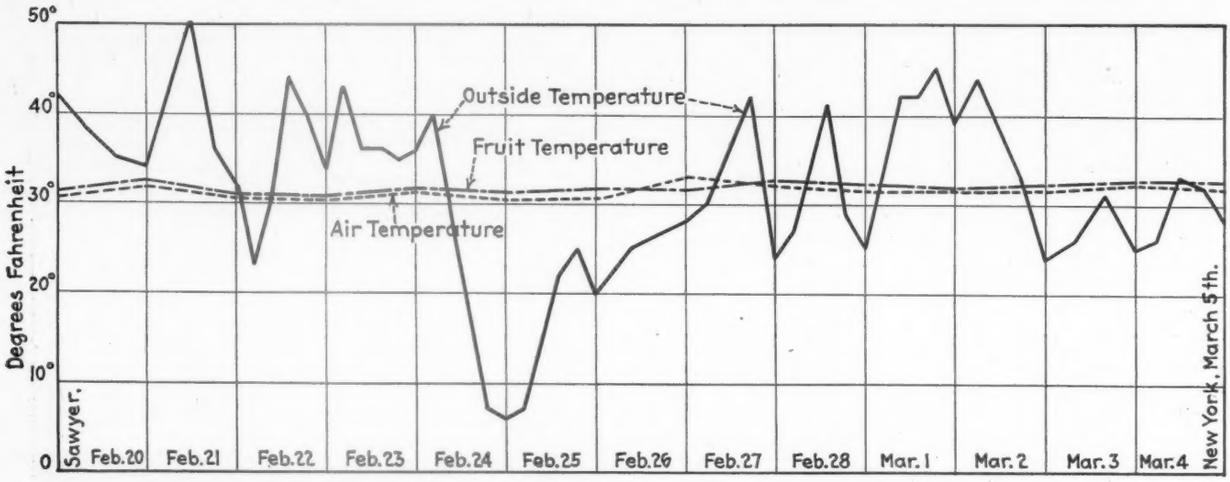
End elevation of the car showing the arrangement of equipment



The Silica Gel system applied to a refrigerator car

is set, when the cooling system is placed in condition to operate as controlled by the car temperature.

The power element or bellows of the car thermostat is utilized to secure a record of the car temperature. The gas motor *1* is in operation continuously while the equipment is in use and by suitable gearing it moves a paper tape *11*. Variations in car temperature cause expansion and contraction of the power element of the thermostat and the lever *17* transmits these movements to the pencil *12* which records them on the moving tape. This gives a continuous record of car temperatures, the middle point on the tape always being the temperature for which the thermostat is set. A safety device is provided so that if the pilot becomes extinguished the gas cannot be turned on the burners. In the event of excessive pressure in an adsorber during activation the gas is automatically shut off from that adsorber.



Temperature observations taken on a load of pears from Yakima Valley, Wash., to New York

Silica Gel Car Tested by U. S. Department of Agriculture

During a recent test conducted under the direction of the United States Department of Agriculture both the heating and refrigerating apparatus on one of the new all-steel cars functioned automatically during a trip from Yakima Valley, Wash., to New York. The car was loaded with 756 boxes of pears, from cold storage, placed in the car at a temperature of 31 deg. F. The air temperature of the car was 32 deg. at the time of loading, the thermostat being set to maintain that degree of temperature and, as seen from one of the illustrations, that temperature was maintained throughout the entire journey across the continent, including two days that the car was held in the Jersey City yards. The outside temperature en route ranged from about 50 deg. during the first part of the journey to about 6 deg. after the car had been on its way a few days.

The car carried and perfectly refrigerated the 756 boxes of pears as against 511 boxes, the average capacity of the ice-bunker type of car. The additional 245 boxes represented a lading increase of 48 per cent, the increase being made possible by the relative compactness of the silica gel apparatus and the overhead system of refrigeration.

Since the first silica gel refrigerator car was placed in operation several years ago it is interesting to note that up to March 31, 1930, the cars have been used for 851 shipments, amounting to approximately 23,000,000 lb., valued at about $8,000,000, with no loss to shipper, consignee or carrier. During this period the cars have travelled approximately 2,300,000 miles, of which nearly 60 per cent have been loaded.

* * *

Drop-bottom gondola cars ready for stencilling on the outbound track of the Galesburg, Ill., steel car shop of the Chicago, Burlington & Quincy

Car with Duryea underframe (right) and car with conventional underframe (left) under twin loading for impact tests

Duryea Cushion Underframe on Nearly 10,000 Cars

Underframe construction in which shock-cushioning and draft functions are separated now standard on Baltimore & Ohio

WITH the rigid limitations imposed on draft-gear travel in order that slack may be kept within practicable limits, increased energy absorption can only be produced with an accompanying increase in end force. The Duryea cushion underframe, which was developed by the O. C. Duryea Corporation, 230 Park avenue, New York, is designed to permit the control of slack and of energy absorption capacity separately, each to meet the most desirable operating conditions, without the necessity of a compromise between them.

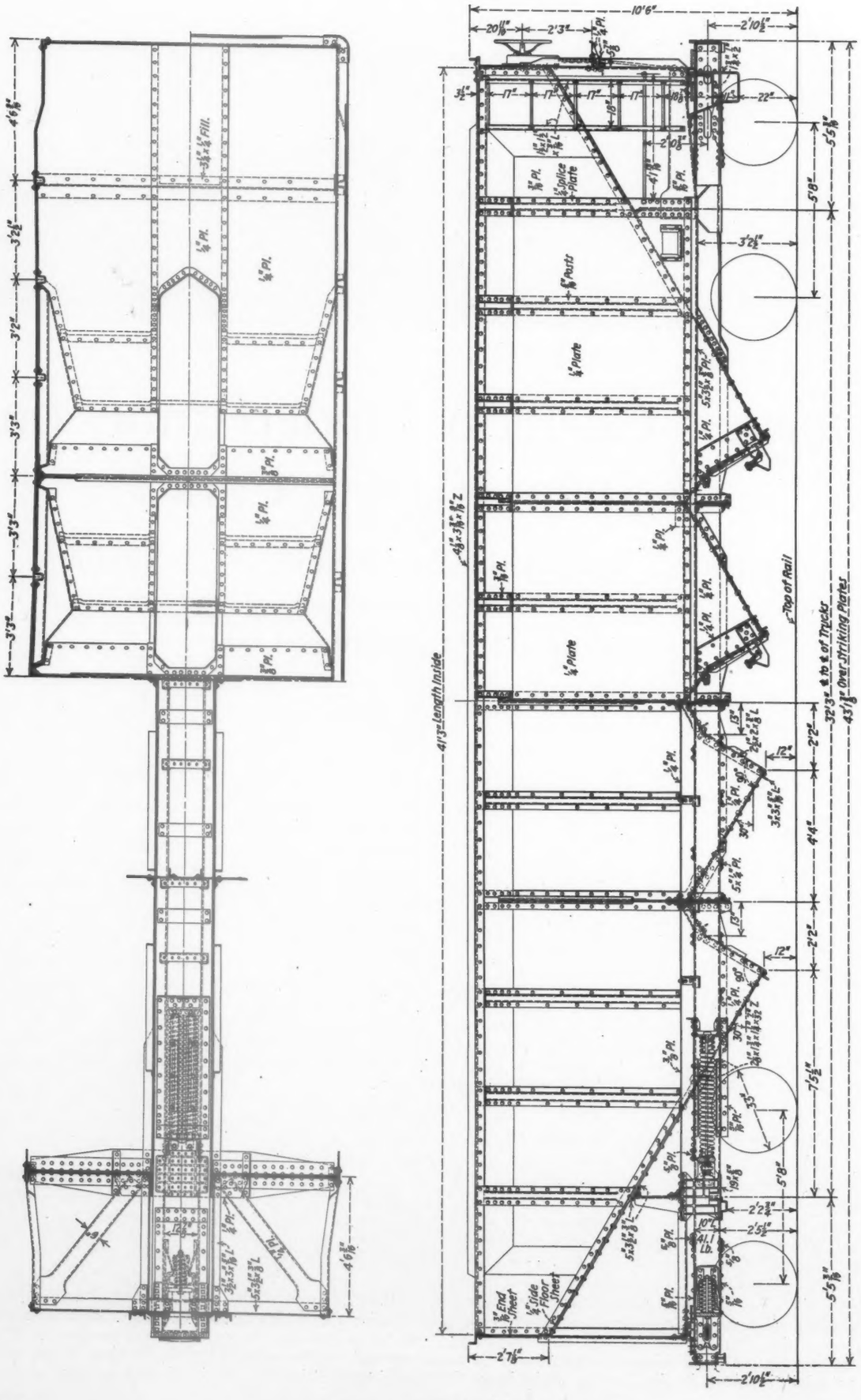
For several years the Baltimore & Ohio has been applying underframes of the Duryea construction to its new freight cars. At the present time this road has 9,601 freight cars so equipped and has adopted this construction as standard for its freight equipment. Of its freight cars now so equipped 5,500 are 50-ton box cars, 2,000 are 70-ton hoppers and 2,000 70-ton gondola cars. The Baltimore & Ohio also has placed in service 100 express cars equipped with the Duryea underframe and has one caboose car under construction.

The Duryea Underframe Construction

Information obtained from various tests and the results obtained in actual service on the Baltimore & Ohio indicate that the Duryea cushion underframe construction should last the life of the car, with lower maintenance costs, less shopping of cars for repairs and less damage to lading than are experienced with cars of the conventional underframe construction. Experience thus far has indicated that repairs to cars equipped with cushion underframes can be made as easily, if not more easily, than is the case with cars embodying the customary type of underframe construction.

The principle involved in the Duryea underframe is the application of a center-sill member mounted and guided within the cross-bearers and bolsters of the underframe, but free to move longitudinally, and connected to the underframe and car body through two cushion gears located between the sills behind the bolsters. The center-sill member in effect forms a rigid draft and buffing column, in the ends of which the couplers and coupler gears are secured. The cushion gears may be designed with a variety of characteristics as to maximum travel, capacity and energy absorption without affecting the amount of slack movement between adjoining cars. The coupler gear embodies a spring of small capacity, having a travel of 1 in., which serves to keep the coupler normally against stops in its most extended position, so that there is no slack between the cars in draft except that between the coupler knuckles. This provides for a slack movement of 2 in. between adjoining cars in buffing to permit the accumulation of sufficient slack to facilitate starting trains.

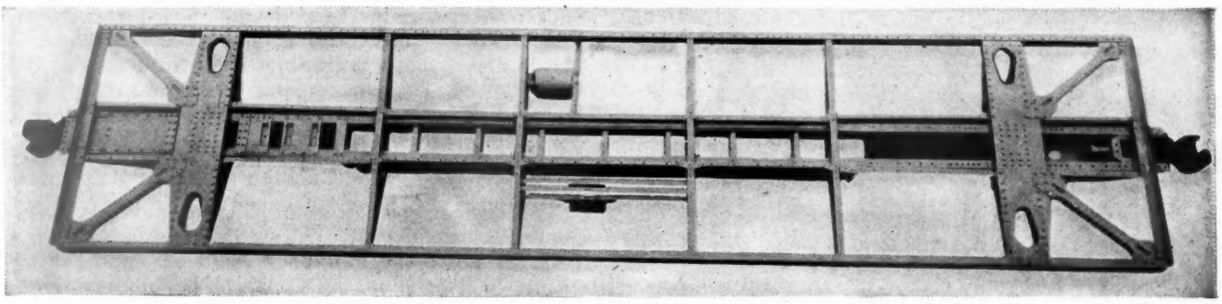
Referring to the drawings of the Baltimore & Ohio 50-ton box cars and the 70-ton hopper car, it will be seen that the Duryea underframe consists essentially of the bolsters, side sills and cross-bearers. The latter are riveted to the side sills and to a series of longitudinal members, adjacent to the longitudinally movable center sills, which are riveted between the various cross-members. With the exception of the torque arms, these members are of relatively light construction. The longitudinal members, which extend back from the bolsters to the adjoining cross-bearers, serve as torque arms to resist the tendency of the bolster, slidably mounted on the center sills, to tip under the moment exerted by the truck at the center plate in braking. Each of these members on the box car is of deep section where it is



Long-travel Duryea cushion underframe as applied to the Baltimore & Ohio 70-ton hopper cars

built into the bolster and tapers upward toward the end which is riveted to the cross-bearer. The slope sheets of the hopper car, which are reinforced with angles, perform the same functions as the torque arms on the box car.

The center sills used in the construction of the Baltimore & Ohio 50-ton box cars and 70-ton hopper cars are 10-in., 41.1-lb. modified shipbuilding channels. Between the ends of the sills and the bolster these channels are secured together with top and bottom cover plates which extend to within a gaged distance of 7 in. from stop faces on the body bolster. The bolster ends

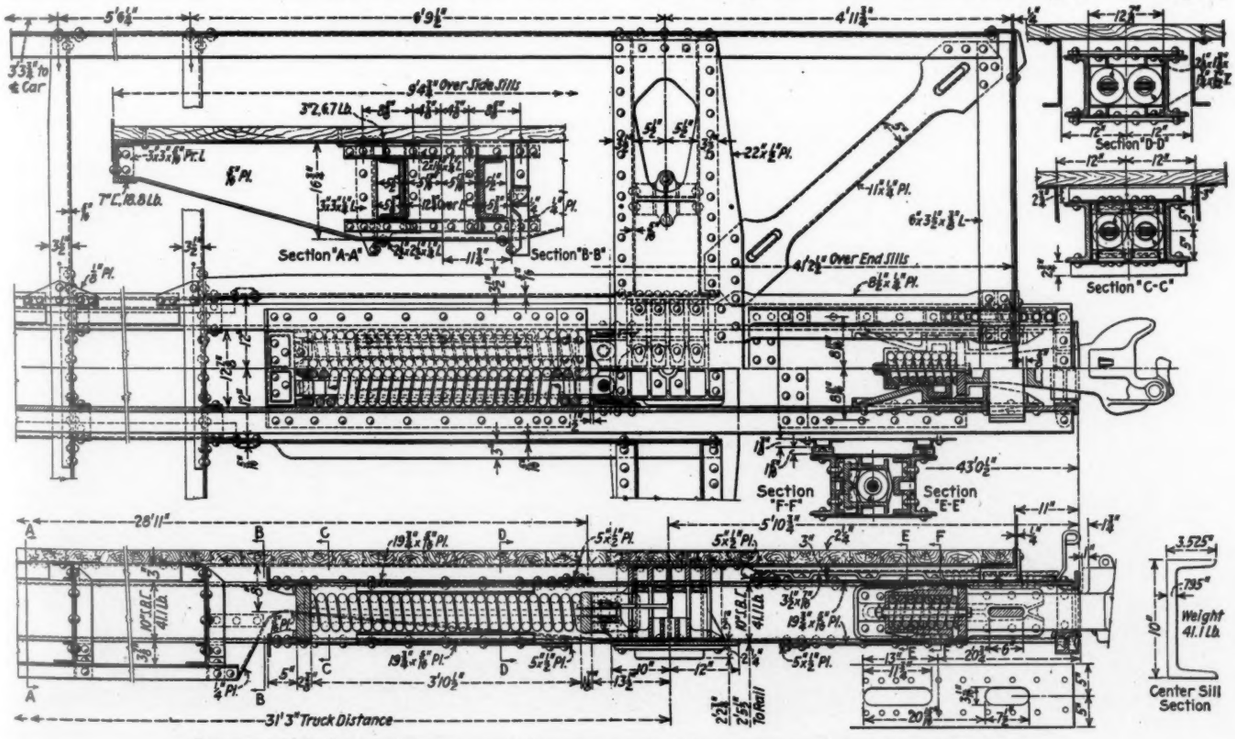


Design of Duryea underframe which was first applied to the B. & O. box cars

of these plates are reinforced with short plates which serve as over-solid stops to limit the inner movement of the center sills toward the bolsters. Similar top and bottom cover plates extend gaged distances of 7 in. from stops on the back faces of the bolsters toward the first cross-bearers, their lengths being determined to clear the cross-bearers when the sills have moved inward by the full amount of their travel. The ends of these plates adjoining the bolsters are reinforced to form over-solid stops when the sills are moved outward through the bolster. In the Baltimore & Ohio cars the maximum travel of the sills has been fixed at 7 in. in either direction, or a total of 14 in. from maximum draft to maximum buff. The space between the the center sills inside the cover plates is devoted to the housing of the cushion gear.

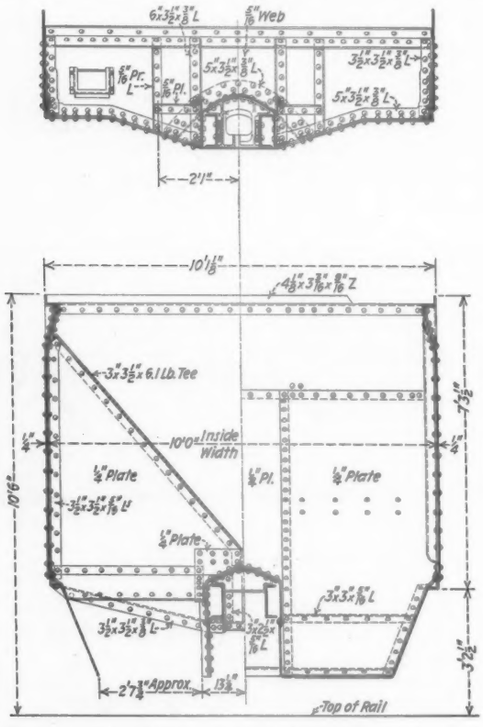
The body bolster is built up of flanged pressings, a center-brace casting framed to receive the center sills and top and bottom cover plates. The torque arms on the box cars, which are also flanged pressings, extend through the entire width of the bolster structure and are riveted to the inner flanges of the bolster pressings, to both top and bottom cover plates and to vertical flanges of the bolster center-brace casting. The floor supports which extend between the two torque-arm cross-bearers are of $\frac{5}{16}$-in. plate, pressed as shown in the drawings.

The cross-bearers on the 50-ton box cars are each continuous structures over the entire width of the car. Each is made up of a single pressing of $\frac{5}{16}$-in. plate which is cut away to provide openings through which the two center sills may pass. The openings are framed at the sides and tops with angles riveted to the cross-bearer and at the bottom with malleable-iron wear plates on which the center sills rest. The cross-bearers are all tied together with continuous longitudinal angles,



Improved design of Duryea underframe as applied to the B. & O. 50-ton box cars

one under each center-sill channel opening, which are riveted to the bottom flanges of the diaphragms. Three-inch, 6.7-lb. Z-bars, resting on top flanges of the center



Sections showing the construction of the 70-ton hopper cars at the bolster, the side braces and the end slope sheets

sills, are tied to the tops of the cross-bearers by gusset plates. These serve as floor supports over the center sills. The floor structure of the hopper car is braced to the sides with 3½-in. by 3½-in. by ⅜-in. angles.

The Coupler Gear

The coupler-gear housing consists of two cheek-plate castings and a spring-pocket casting. Key lugs on the cheek-plate castings are framed into the webs of the two center-sill channels and the castings are securely riveted in place. The spring-pocket casting seats against lugs provided on the cheek plates and forms a pocket for the coupler-gear spring. This spring has a free height of 13 in. and consists of a single coil of 1-11/32-in. bar, $5\frac{7}{16}$ in. in outside diameter. This spring closes with a total travel of 2¼ in., developing a maximum force of 20,700 lb. It is assembled behind the coupler with an initial compression of 1 in. under a load of 9,200 lb. The coupler is secured in place by a 6-in. by 1½-in. draft key passing through the sill and cheek plates. The springs normally hold the coupler out against the key, which in turn bears against the front ends of the slots in the sills and cheek-plates. Under buffing loads, however, the coupler and follower are driven back against the spring through a travel of 1 in., the follower then going solid against the spring pocket, which distributes the load through the cheek plates to the center sills.

The Cushion Gear

The cushion gear is a simple spring device without friction elements. It consists of two single coils of 1-17/32-in. bar, 6¼ in. outside diameter, and 51 in. free height, held in alinement between the sills and Z-bars, riveted on the inside of the top and bottom cover plates. These springs are assembled with an initial compression of 4½ in., allowing a total gaged length between stops of 4 ft. 2¼ in., and go solid at a total compression of 12 in. The stops are so arranged that the sills and bolsters go solid after a spring travel of 7 in., which is ½ in. less than the solid compression of the springs. Tension links extend through the coils and are keyed against a follower plate at the inner ends of the springs. At the bolster ends of the springs these links are secured by pins to lugs on the bolster center-brace casting.

In order that the action of the cushion gear may be clearly visualized, consideration will be given to the action at one end of the car, first with the sill subjected to a buffing force and next with the sill subjected to a pulling force, keeping in mind, however, the fact that both gears act in either direction and that the capacity of both gears is involved in both cases.

Under a buffing force sufficient to overcome an initial compression of between 48,000 and 49,000 lb. for the

Baltimore & Ohio 50-ton box car equipped with the Duryea underframe

two gears, the outer follower lugs on the center sills first take up the ⅛-in. clearance between them and the follower, which normally rests against the face of the bolster center-brace casting. Further movement in the same direction picks up the follower, carrying it away from the face of the bolster and compressing the springs against the inner follower which is retained in a fixed position with respect to the bolster and car body by the tension links. Under a sufficient force, this movement may continue until the outer over-solid stops on the center sill engage the outer face of the bolster.

Assuming a pulling force applied to the end of the center sill sufficient to overcome the initial load on the springs, the inner follower lugs on the center sill carry the spring follower away from the tension-link keys and compress the spring against the outer follower, which bears against the inner face of the bolster center-brace casting. This compression may be continued until the inner sill over-solid stops strike the inner face of the bolster center-brace casting after a maximum travel of 7 in.

The combined action of the two gears in the same car may now be clearly visualized by remembering that when the gear at one end is acting as described for a buffing shock at that end of the car, the gear at the other end is acting as described for a pulling force at its end of the car. The cushion-gear springs are compressed only by forces causing rapid acceleration or deceleration of the car speed. Normally in train service the gears hold the car body in its normal position with respect to the center sills, without the multitudinous small movements encountered in the conventional types of draft gears.

The end force for complete closure of both gears is approximately 131,500 lb. With the initial compression as described, this provides a maximum energy capacity of something over 50,000 ft. lb. The A. R. A. specifications for friction draft gears call for a maximum travel of 2¾ in. and capacity limits of 18,000 and 27,000 ft. lb. Within these limits maximum end forces range upward from approximately 300,000 lb.

The springs in the gear described are of double heat-treated silico-manganese steel.

Operation and Service Tests

Numerous tests of this type of underframe construction have been made since the first demonstrations at the Butler, Pa., plant of the Standard Steel Car Company in December, 1927. One of these demonstrations consisted of dropping five new steel hopper cars against a box car equipped with a Duryea cushion underframe which was standing with the brakes applied to hold it fast. The speed of the cars when striking the box car was approximately eight miles an hour. A piece of lead was placed between the striking horn of the coupler and the striking casting of the box car, and also behind the coupler horn on the hopper car which contacted with the box car.

These tests showed that the coupler horn on the box car failed to contact with the striking casting and that the cushion effect in the Duryea underframe had not been completely taken up.

With the object of obtaining further information relative to the performance of the cushion underframe, a test was made in January, 1929, at the Mt. Clare (Baltimore, Md.) shops of the Baltimore & Ohio which consisted of dropping three loaded 70-ton all-steel hopper cars against a 50-ton box car equipped with the Duryea underframe, which was loaded with 110,000 lb. of scrap backed up by six loaded hopper cars of the conventional type which were anchored by setting the brakes and chaining and blocking to the track. The purpose of this test was to ascertain whether or not such abuse would damage the Duryea cushion underframe car. The test consisted of a number of impact runs against the car at increasing speeds. At the conclusion of these tests an examination showed that the Duryea car draft keys were bent ¼ in. and that the end car of conventional design had one truck derailed and center-plate rivets sheared. While the abuse given the box car was considerably beyond that which would be permitted in regular service and would only occur in case of accident, the test showed that the Duryea underframe car would stand up under such treatment.

In order to provide additional information relative to the operating characteristics of cars equipped with the Duryea underframe, dynamometer tests were made on the Adamstown branch of the Baltimore & Ohio the latter part of April, 1929. These tests proved to the satisfaction of the railroad that trains composed of cars equipped with the Duryea underframe could be handled over the road with more ease and less damage to equipment and could withstand emergency applications of the air brakes without derailment and without damage to the equipment or lading. In all the brake tests the Duryea underframes absorbed the shocks from either service or emergency applications. Movements of the car bodies on the center sills of from 1 in. to 1½ in. resulted from emergency applications at 12 m.p.h. with a 100-car train, and 13.1 m.p.h. with a 125-car train. Impacts due to emergency application, which were registered in the dynamometer car at the head of the train, a car in the center of the train and the last car in the train, showed none of the impacts to be of a force that would indicate abuse or rough handling.

About a year ago the Baltimore & Ohio made a series of comparative tests between six cars equipped with the Duryea cushion underframe and six cars of conventional underframe construction. Eleven of the cars were loaded with sewer pipe and one A. R. A. car was loaded with drain tile. The breakage in clay products lading of this class was 88 per cent more for the A. R. A. car than for those having the Duryea underframes.

Tests of Multiple Loading

It was suggested by a shipper that it might not be safe to make shipments of multiple loaded cars equipped with Duryea underframes, or such loading on mixed cars composed of one or more cars equipped with the Duryea underframe and one or more with the conventional underframe. With the object of ascertaining the behavior of multiple loads under such conditions, tests were made during the latter part of April, 1930, which led to the conclusion that lading could be handled more satisfactorily on two or more cars equipped with the Duryea underframe than those equipped with the conventional underframe. These tests also indicated that such lading could be placed on mixed cars equipped with both Duryea and conventional underframes without damaging the car or lading more than would have occurred if the loaded cars had all been equipped with conventional underframes.

These tests consisted of five different combinations of cars under multiple lading; namely, two Duryea-underframe cars with the coupler horns blocked; two conventional-underframe cars with the coupler horns blocked; two Duryea-underframe cars without blocking behind the couplers; one Duryea-underframe and one

(Concluded on page 453)

Central Railroad of New Jersey 0-8-0 switching locomotive, built by the Baldwin Locomotive Works

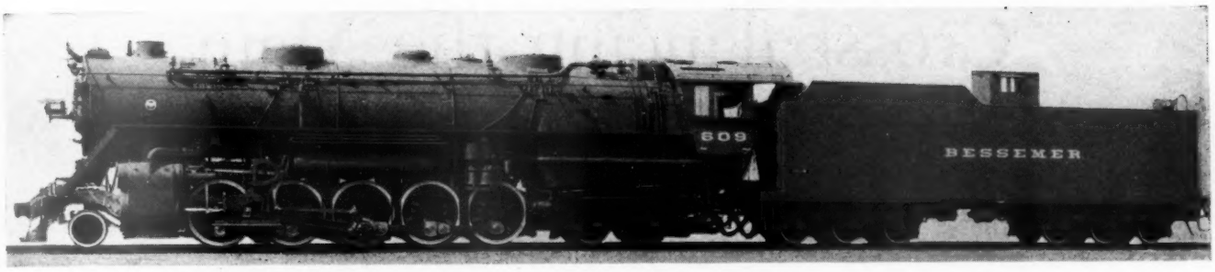
Locomotives Recently Delivered

General Dimensions and Weights

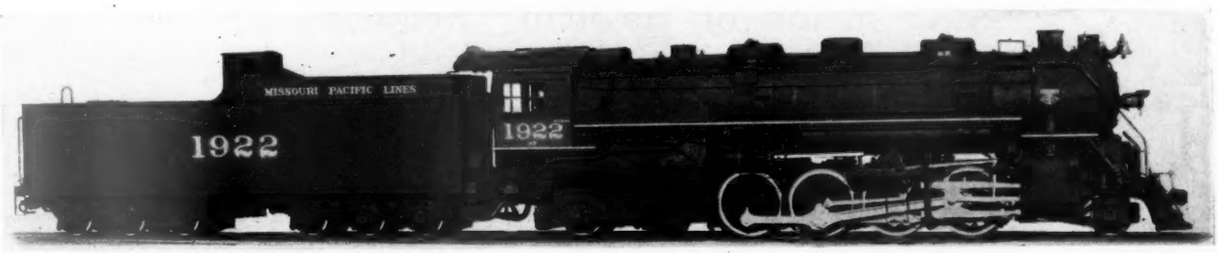
Type	0–6–0	0–8–0	0–8–0	0–8–0	2–8–2	2–8–2	2–8–2	2–8–2	2–8–4	2–10–0	2–10–4
Railroad	K.&I.T.	K.&I.T.	Erie	C.R.R. of N.J.	St.L.-S.F.	West. Pac.	C.I.&L.	E.J.&E.	Mo.Pac.	S.A.L.	B.&L.E.
Builder	Lima	Lima	Bald.	Bald.	Bald.	Amer.	Amer.	Bald.	Lima	Bald.	Bald.
Road class	.....	.....	C-3	.....	.....	.....	.....	.....	.....	D-3	H1-b
Road number	40	35	241	319	4210	335	573	763	1922	533	609
Tractive force, engine, lb.	46,700	55,300	57,000	64,090	66,700	60,300	65,170	58,800	69,400	46,510	96,700
Tractive force, booster or aux. loco., lb.	.....	.....	.....	.....	11,700	11,000	.....	10,900	.....	.....	13,100
Cylinder horsepower (Cole)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
ENGINE AND TENDER DATA											
Weight of engine, lb.	193,500	229,000	236,280	262,170	375,790	332,000	335,000	332,460	412,200	212,000	506,970
Weight on drivers, lb.	193,500	229,000	236,280	262,170	274,690	249,000	252,500	244,590	275,500	190,000	362,050
Weight on front truck, lb.	.....	.....	.....	.....	37,000	25,500	28,000	27,910	39,800	22,000	36,930
Weight on trailing truck, lb.	.....	.....	.....	.....	64,100	57,500	54,500	59,960	96,900	.....	107,990
Weight of tender, loaded, lb.	174,100	201,300	368,620	174,430	232,910	267,000	219,700	189,340	321,700	136,100	365,330
Tender, water capacity, gal.	10,000	12,000	20,000	10,000	10,000	15,000	12,000	10,000	17,250	7,000	22,000
Tender, fuel capacity, tons or gal.	12	15	28	13	17	4,000	20	15	20	12	23
Wheel base, driving, ft. and in.	11—6	15—0	15—0	15—3	16—9	16—6	16—9	16—6	16—9	19—8	22—4
Wheel base, engine, ft. and in.	11—6	15—0	15—0	15—3	37—7	36—3	36—11	36—2	40—5	28—3	45—6
Wheel base, engine and tender, ft. and in.	50—0¼	58—6½	68—2⅝	54—3⅜	76—3¼	73—2½	76—5¾	68—7½	85—0¾	60—7¼	95—2
Cylinders, diameter and stroke, in.	23x28	25x28	25x28	24x30	27x32	28x30	27x32	28x30	28x30	24x28	31x32
Driving wheels, diameter, in.	51	51	52	55	63	63	63	63	63	56	64
BOILER DATA											
Steam pressure, lb.	200	200	200	240	230	190	220	185	240	190	250
Fuel	Soft coal	Soft coal	Coal	H.&C. coal	Soft coal	Oil	Soft coal	Soft coal	Soft coal	Soft coal	Soft coal
Boiler, diameter, first ring, in.	72	80	80	78⅛	86	82	84½	80	88	70	92
Firebox, length, in.	90⅛	102⅝	102⅛	121⅝	120⅛	120⅛	120⅛	114⅛	132⅝	108	150
Firebox, width, in.	72¼	66¼	66¼	108⅛	96¼	84¼	96¼	72	96¼	72¼	102¼
Tubes, number and diameter, in.	182—2	230—2	228—2	208—2	66—2¼	213—2¼	231—2¼	245—2	84—2¼	167—2	87—2¼
Flues, number and diameter, in.	30—5½	36—5½	36—5½	34—5½	201—3½	45—5½	50—5½	43—5⅜	204—3½	28—5¾	222—3½
Length over tube sheets, ft. and in.	15—0	15—0	15—0	15—0	18—0	18—0	19—0	20—6	21—6	17—0	21—6
Grate area, sq. ft.	45.0	46.9	46.8	91.7	80.3	70.3	80.3	57	88.3	54.3	106.5
Heating surface, firebox, total, sq. ft.	182	214	212	340	390	391	385	314	356.5	197	570
Heating surface, tubes and flues, sq. ft.	2,063	2,569	2,554	2,354	3,994	3,407	3,934	3,853	5,057	2,146	5,455
Heating surface, total evap., sq. ft.	2,245	2,783	2,766	2,694	4,384	3,798	4,319	4,167	5,413.5	2,343	6,025
Superheating surface, sq. ft.	543	637	637	574	1,920	973	1,166	1,032	2,330	553	2,487
Comb. evap. and super. surface, sq. ft.	2,788	3,420	3,413	3,268	6,304	4,771	5,485	5,199	7,743.5	2,896	8,512

Note: Tenders on Erie 0-8-0 locomotive to be transferred to road engines.

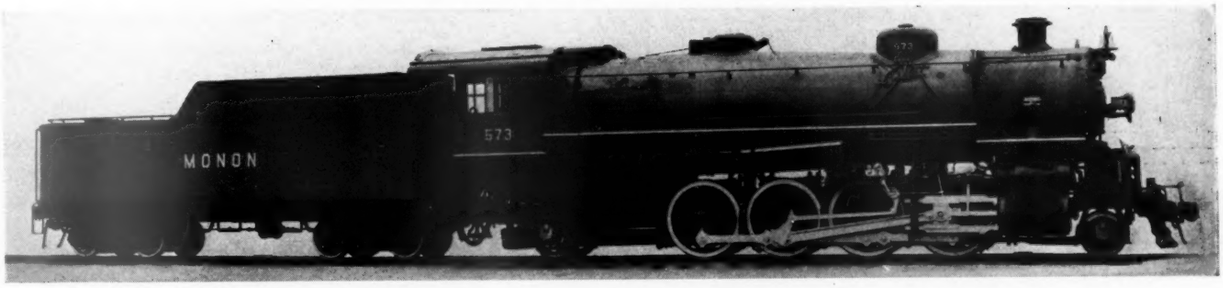
Western Pacific 2-8-2 type locomotive, built by the American Locomotive Company



Bessemer & Lake Erie 2-10-4 type locomotive built by the Baldwin Locomotive Works



Misscuri Pacific 2-8-4 type locomotive, built by the Lima Locomotive Works



Chicago, Indianapolis & Louisville 2-8-2 type locomotive, built by the American Locomotive Company

St. Louis-San Francisco 2-8-2 type locomotive, built by the Baldwin Locomotive Works

Kentucky & Indiana Terminal 0-6-0 switching locomotive, built by the Lima Locomotive Works

Crossbalancing the Main Driving Wheel

A. R. A. report illustrates calculations of weight and position of balance for out-of-plane action of revolving weights

THE trend toward larger locomotives with their higher piston thrusts, greater wheel loads, heavier revolving and reciprocating parts, and greater overhang of side rods, main rods and eccentric cranks, together with the fact that the yearly number of rail failures is steadily mounting, makes it imperative that greater refinements of counterbalancing be considered. This article, which is an abstract of the report of the Mechanical Division Committee on Locomotive Design and Construction presented at the 1930 convention, shows how a reduction of the rail blow or dynamic augment caused by the vertically unbalanced component of the revolving counterbalances can be accomplished.

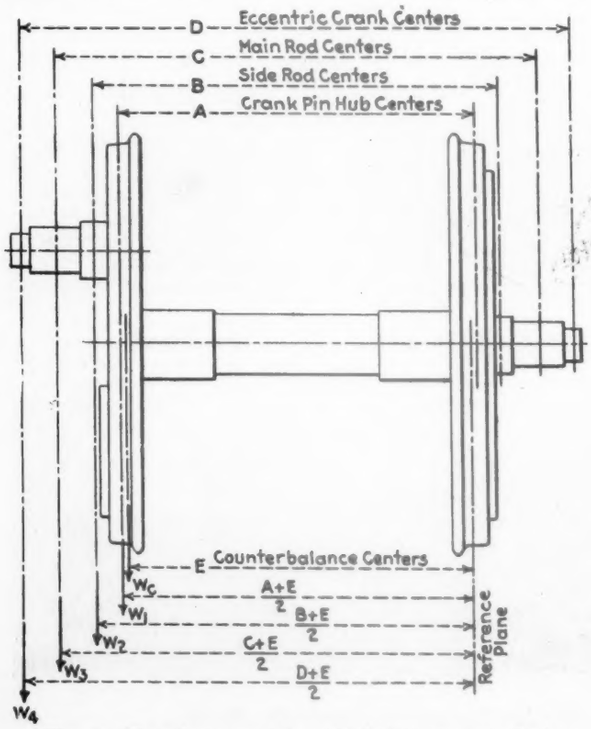


Fig. 1—Notations used in calculating the required counterweights

Crossbalancing of the main driver for the overhang or out-of-plane action of the side rods, main rod, eccentric crank and crank pin seems to offer the greatest possibilities for reduction of the rail blow and smoother operation. There is nothing new about this method, but a questionnaire which was sent to the railroads and locomotive builders revealed that it is used very little in this country. The following diagrams and accompanying formulae illustrate the method now in use for calculating the weight of the counterbalance and the position it must take to balance fully the out-of-plane action of the revolving weights. Crossbalancing of the coupled drivers will not be considered since the portion of the weight of the side rods borne by each coupled driver is relatively low and the cross centers of the side rods are but little greater than those of the counterbalances.

Referring to Fig. 1 and considering the main driver only, the following notations are used:

A = Crank-pin hub centers in inches.
B = Side-rod centers in inches.
C = Main-rod or cylinder centers in inches.
D = Eccentric-crank centers in inches.
E = Counterbalance centers in inches.
W_1 = Weight of crank-pin hub with included part of crank-pin in pounds.
W_2 = Weight of part of side-rod with included part of crank-pin in pounds.
W_3 = Weight of back end of main-rod with included part of crank-pin in pounds.
W_4 = Weight of eccentric-crank with included part of crank-pin in pounds.
W_t = Total revolving weights = $W_1 + W_2 + W_3 + W_4$.

To balance completely the forces set up by the revolving of these overhanging weights requires two counterweights, one in the same wheel in which the crank pin is set, and one in the opposite wheel. By considering the moments produced by the various weights acting at their respective distances from a reference plane through the counterbalance center of the opposite wheel, the counterweight required in the adjacent wheel directly opposite the crank-pin hub and acting at crank-pin radius is

$$W_c = \frac{W_1 \frac{A+E}{2} + W_2 \frac{B+E}{2} + W_3 \frac{C+E}{2} + W_4 \frac{D+E}{2}}{E}$$

which can be simplified to:

$$W_c = \frac{W_1 A + W_2 B + W_3 C + W_4 D}{2E} + \frac{W_t}{2}$$

The resulting cross-force acting in the plane of the counter-balance of the opposite wheel, designated by F in Fig. 3, must be balanced in that wheel by a counterweight, which is equal to $W_c - W_t$ acting at the crank-pin radius; since from Fig. 2 for a condition of perfect balance W_c must equal $W_t + W_r$ or $W_r = W_c - W_t$. As the cranks in the wheels are set 90 deg. apart, the cross-force acting from the crank of one wheel into the opposite wheel is directed at right angles to a line through that wheel's crank pin and axle centers. To combine this counterweight necessary to balance this cross-force, with that required opposite the crank pin in this wheel, it is necessary to set the final counterweight at an angle to the line through the crank and axle centers. This angle would be one whose tangent

equals $\frac{W_c - W_t}{W_c}$ designated as θ in Fig. 3 and the amount of counterweight at this angle equals

$$\sqrt{W^2_c + (W_c - W_t)^2}$$

As shown by Fig. 3, if the right crank leads the left crank, the counterbalance in the right wheel must be advanced by the amount of the angle and set back by the same amount in the left wheel. If the left crank leads the right, then the reverse is true. In other words, the counterbalance must be turned toward the position of the opposite crank pin. It should be noted here that one pattern will serve for both wheels. Let

R = Distance from center of gravity of final counterbalance to axle center
r = Crank radius

then amount of final counterbalance is equal to

$$\frac{r\ \sqrt{W^2_c + (W_c - W_t)^2}}{R}$$

Apply this to a two-cylinder engine of the following dimensions:

Type	2 cylinder, 4-8-2
Cylinders, diameter and stroke	28 in. by 30 in.
Wheel diameter	69 in.
Weight on drivers	257,500 lb.
Weight engine (less tender)	376,000 lb.
Weight of reciprocating parts including piston complete, crosshead complete with wrist pin and union link and front end of main rod complete	1,888 lb.
Weight of back end of main rod with bushing and included part of crank pin	964 lb.
Weight of eccentric crank with included part of crank pin	153 lb.
Weight of side rod at main wheel with included portion of crank pin	718 lb.
Weight of crank-pin hub with included part of crank pin	395 lb.
Weight of side rod, crank pin and hub on intermediate driver	730 lb.
Weight of side rod, crank pin and hub on first and fourth drivers	400 lb.
Cylinder centers	92 in.
Side rod centers	76¾ in.
Eccentric-crank centers	104¾ in.
Crank-pin hub centers	63½ in.
Counterbalance centers	63 in.
Right crank leading left by	90 deg.
W_1 = 395 lb.	A = 63½ in.
W_2 = 718 lb.	B = 76¾ in.
W_3 = 964 lb.	C = 92 in.
W_4 = 153 lb.	D = 104¾ in.
W_t = 2230 lb.	E = 63 in.

$$W_c = \frac{395 \times 63\frac{1}{2} + 718 \times 76\frac{3}{4} + 964 \times 92 + 153 \times 104\frac{3}{4}}{2 \times 63} + \frac{2,230}{2}$$

W_c = 2,582 lb.

$W_c - W_t$ = 2,582 — 2,230 = 352 lb.

θ = the angle whose tangent is $\left(\frac{352}{2,582} = .13632\right)$

θ = 7 deg. 46 min.

Counterweight at crank pin radius = $\sqrt{2,582^2 + 352^2}$ = 2,606 lb.

If R = 15½ in. = radius of center of gravity of counterbalance,
r = 15 in. = crank radius

Final weight of counterbalance required to balance the revolving parts:

$$\left(\frac{15 \times 2,606}{15.5}\right) = 2,522 \text{ lb.}$$

Advantages of Crossbalancing

The table illustrates the advantages to be gained by and the effects produced when not crossbalancing. It has been computed to compare the dynamic augment produced by each driver by the different methods of balancing now in use, when applied to an engine of the foregoing dimensions. Method (a) is the ordinary or A. R. A. method of balancing all the revolving weights and 50 per cent of the reciprocating weights equally distributed. Method (b) is the ordinary method of balancing all the revolving weights and 66⅔ per cent of the reciprocating weights equally distributed. Method (c) balances all the revolving weights by the ordinary method and 50 per cent of the reciprocating weights distributed with 40 per cent in the main, 22 per cent in the intermediate and 19 per cent in each the front and back wheels. Method (d) crossbalances all the revolving weights and balances 50 per cent of the reciprocating weights equally distributed. Method (e) crossbalances all the revolving weights and balances 31½ per cent of the reciprocating weights equally distributed.

The cross effect of the reciprocating weights acting on the crank pin is not considered in the table and no crossbalancing of the coupled drivers is attempted.

Line 3 for the first three methods is the sum of lines

Comparison of the dynamic augment produced by each driver by the different methods of balancing

Line No.		(1) Method of balancing used	(2) First driver	(3) Main driver	(4) Inter. driver	(5) Fourth driver	(6) Total	(7) Per cent reciprocating weights
1	Revolving weights to be counterbalanced — with all methods, lb.	...	400	2,230	730	400	3,760	....
2	Weight added for a partial reciprocating balance, lb.	(a)	236	236	236	236	944	50
		(b)	315	315	315	315	1,260	66⅔
		(c)	179	378	208	179	944	50
		(d)	236	236	236	236	944	50
		(e)	148	148	148	148	592	31½
3	Total weight of counterbalance at crank-pin radius, lb.	(a)	636	2,466	966	636	4,704	....
		(b)	715	2,545	1,045	715	5,020	....
		(c)	579	2,608	938	579	4,704	....
		(d)	636	2,842	966	636	5,080	....
		(e)	548	2,754	878	548	4,728	....
4	Resultant producing dynamic augment, lb.	(a)	236	370	236	236	592	....
		(b)	315	354	315	315	907	....
		(c)	179	353	208	179	592	....
		(d)	236	236	236	236	944	....
		(e)	148	148	148	148	592	....
5	Dynamic augment on one side at diameter speed, lb.	(a)	11,328	17,760	11,328	11,328	28,416	....
		(b)	15,120	16,992	15,120	15,120	44,536	....
		(c)	8,592	16,944	9,984	8,592	28,416	...
		(d)	11,328	11,328	11,328	11,328	45,312	....
		(e)	7,104	7,104	7,104	7,104	28,416	....
6	Effective reciprocating balance, lb.	(a)	236	—116	236	236	592	31½
		(b)	315	— 38	315	315	907	48
		(c)	179	26	208	179	592	31½
		(d)	236	236	236	236	944	50
		(e)	148	148	148	148	592	31½

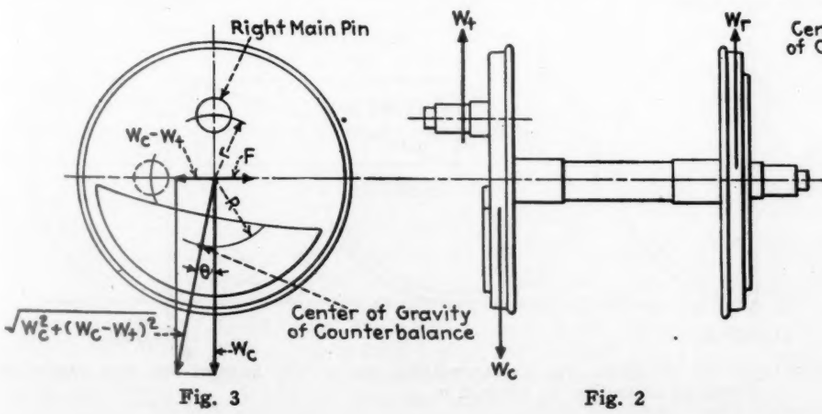


Fig. 3

Fig. 2

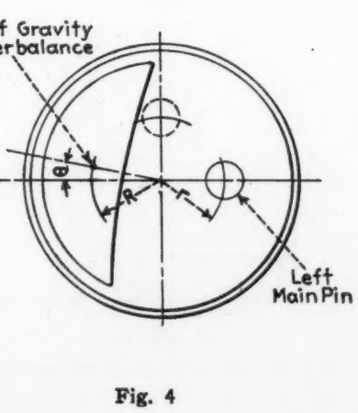


Fig. 4

1 and 2 for each driver. This also applies to methods (d) and (e) for all drivers except the main which is the weight of counterweight at crank-pin radius as found before as 2,606 lb. plus 236 lb. in one case, and 2,606 lb. plus 148 lb. in the other.

Line 4 for all drivers except the main is considered as being equal to the weight added to that driver's counterweight partially to balance the reciprocating parts. In the case of the main driving wheel, the cross effect of the out-of-plane weights must be considered. From the previous calculation, there must be 2,582 lb. in the plane of the counterbalance directly opposite the main pin. Less or more than that, which is the case in methods (a), (b) and (c) (line 3), results in a force equal to this difference which, combined with the cross force of 352 lb. from the opposite wheel, gives the resultant acting in the wheel.

For method (a) this equals $\sqrt{352^2 + (2{,}582 - 2{,}466)^2} = 370$ lb.
For method (b) this equals $\sqrt{352^2 + (2{,}582 - 2{,}545)^2} = 354$ lb.
For method (c) this equals $\sqrt{352^2 + (2{,}608 - 2{,}582)^2} = 353$ lb.

Line 5 for all drivers is derived from the formula that the dynamic augment at diameter speed equals the unbalanced resultant in pounds times 3.2 times ½ the stroke in inches. The totals shown in column 6 represent the total rail augment when the counterweights are at the bottom of their travel.

Referring to Fig. 5, the resultant acting in the main wheel when it is balanced according to method (a) is not acting with the counterbalance nor with the crank pin, but at an angle of 72 deg. in advance of the latter. The resultant for the other drivers is entirely due to their overbalance and hence is acting with their counterbalance. Fig. 6 shows that, when the engine is balanced according to method (a) and the position of the counterweights is at the bottom, the main wheel augment is a minus quantity, that is, it is acting away from the rail and is equal to $(2{,}582 - 2{,}466) \times 3.2 \times \frac{30}{2} = 5{,}568$ lb. The total, therefore, is $3 \times 11{,}328 - 5{,}568 = 28{,}416$ lb. Thus the dynamic augment in the main driver does not occur at the same time that it does in the other drivers but at a time when the counterbalances are 180 deg. — 72 deg. = 18 deg. above a horizontal position and toward the back. This also applies in the case of method (b) but, the counterbalance being heavier, the negative augment is smaller and the main driver augment occurs when the counterbalances are very nearly at a horizontal position. In the case of method (c) where the counterbalance is heavier than the 2,582 lb. required, the component producing the augment when the counterbalances are down, is acting with that of the other wheels and should be added, thus: $(2{,}608 - 2{,}582) \times 3.2 \times \frac{30}{2} + 2 \times 8{,}592 + 9{,}984 = 28{,}416$ lb.

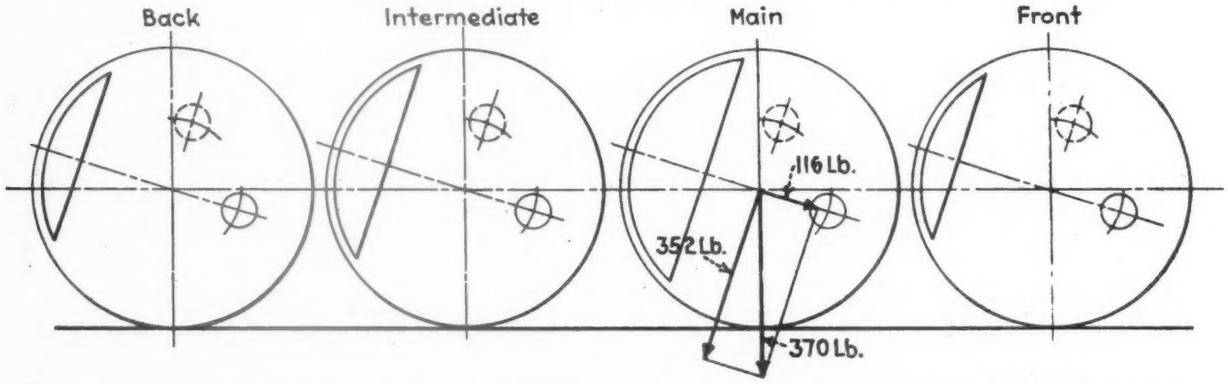


Fig. 5—The resultant in the main wheel when it is balanced according to method *a* acts at an angle of 72 deg. in front of the crank pin

In the case of methods (d) and (e) where the cross effect of the revolving weights has been completely balanced, it is only necessary to consider the augment caused by the weight added to the main balance to effect a partial balance of the reciprocating parts which is the same as was done for the coupled drivers.

A false value for the dynamic augment may be calculated by the ordinary method. If, for method (a), we take the amount of the overweight or 236 lb. as the resultant producing the main wheel augment when actually it should be 370 lb., as shown in line 4 (a), column 3, the augument would be calculated as 11,328

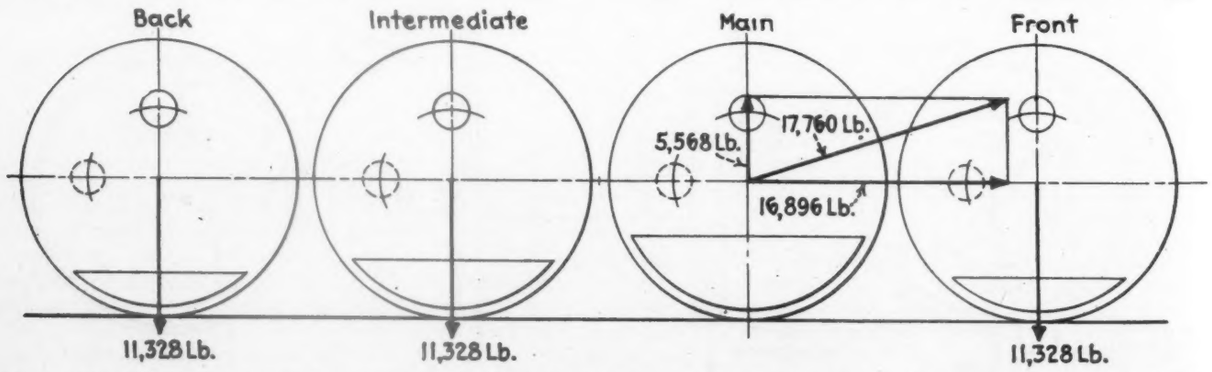


Fig. 6—The main wheel augment acts away from the rail when the counterweights are at the bottom and the engine is balanced according to method *a*

lb., instead of 17,760 lb., which would be produced by 370 lb.

Line 6 shows the effective reciprocating weight balanced by each method. For the main, with methods (a) and (b), this appears as a minus quantity since any weight added to the main driver before the total becomes 2,582 lb. only serves to balance the revolving weights hung thereon. Thus, in the case of method (a), the main driver balance is 116 lb. short of the required 2,582 lb., and so this amount must be taken from the weight placed in the other drivers before a complete balance of the revolving weights in the main driver is effected. Thus, $236 \times 3 - 116 = 592$ lb. which instead of being 50 per cent of the reciprocating weights is only 31½ per cent. In the case of method (b), all but 38 lb. is balanced and instead of balancing 66⅔ per cent of the reciprocating weights, 48 per cent is actually balanced. Likewise, in method (c), only 31½ per cent of the reciprocating weights is balanced. With methods (d) and (e), enough has been added to the main balance to balance completely the revolving weights so all else that is added goes to balance the reciprocating weights.

It is observed here that the total dynamic augment shown in column 6 of line 5 is directly proportional to the percentage of reciprocating weights actually balanced, as shown in column 7, line 6, and can be found by using the total effective reciprocating balance in the formula:

$$W \times 3.2 \times \tfrac{1}{2} \text{ stroke}$$

Thus, $592 \times 3.2 \times 15 = 28{,}416$ lb. It is to be noted that the main wheel augment becomes less as the counterweight is increased. Unless the counterweight is placed at an angle, however, there is no advantage to be gained by increasing the weight beyond the 2,582 lb., since it is the 352 lb. acting at right angles that must then be overcome and this cannot be done without angling the balance.

Considering that engines built on the ordinary method —method (a) in the table—have given good service and have not been particularly rough, either in fore and aft vibrations or nosing, it follows that it is perhaps sufficient actually to balance only 31½ per cent of the reciprocating weights. This being the case, it should be permissible first to crossbalance the revolving weights, then add 31½ per cent of the reciprocating weights equally distributed in each wheel. It is to illustrate this that method (e) is shown in the table. As shown in line 2 (e), column 7, it is attempted to balance only 31½ per cent of the reciprocating weights. Line 5, column 3, shows that the dynamic augment will be reduced by 10,660 lb. in the main driver under that produced by the A. R. A. or ordinary method, and would mean that the main-wheel augment for this engine, weighing 32,200 lb. per wheel, would be reduced from 55 per cent of the static weight on the wheel to 22 per cent and still be balanced with the same percentage of reciprocating weights. Also, while the total augment of 28,416 lb. on rail is the same as produced by the ordinary method, the distribution of this augment among the four drivers is uniform.

Consider the case of the main wheel when the wheel center is too small to accommodate a counterbalance of sufficient weight to effect a complete crossbalance. As an example, assume that only 80 per cent of the weight required for a crossbalance plus one-quarter of 50 per cent of the reciprocating weights can be accommodated; that is, 80 per cent of 2,842 lb., line 3 (d), column 3 of table, or 2,274 lb. If the counterweight is placed at the proper angle of 7 deg. 46 min. the deficiency will be 2,606 lb.—2,274 lb., or 332 lb. On the other hand, if the counterweight is not angled but placed directly opposite the crank pin, the deficiency will be 2,582 lb. — 2,274 lb., or 308 lb., and the resultant producing the dynamic augment will then be $\sqrt{308^2 + 352^2} = 468$ lb. Hence the dynamic augment in this case is lessened by $\frac{468-332}{468}$ or 29 per cent by turning the counterbalance to the proper angle. The dynamic augment in one case will be 15,936 lb., and in the other case 22,464 lb. Any deficiency in balancing the revolving weights in any wheel will reduce the total overbalance for the reciprocating parts by the amount of that deficiency, which in one instance is 332 lb., and in the other is 308 lb. Hence, to balance a full 50 per cent of the reciprocating weights, weights must be placed in the three coupled drivers that will total in one case $\frac{1{,}888}{2} + 332$, or 1,276 lb., and in the other $\frac{1{,}888}{2} + 308$ or 1252 lb. Likewise, to balance 31½ per cent, we must add $.315 \times 1{,}888 + 332 = 924$ lb., or $.315 \times 1{,}888 + 308 = 900$ lb. As explained, the total rail loading will be the same whether the counterbalance is placed at an angle or not since the same percentage of reciprocating parts is balanced in either case but a reduction is made in the rail blow delivered by the main driver of 15,936 lb. as compared with 22,464 lb.

Three-Cylinder Locomotives

Considering the three-cylinder locomotive, it is also necessary to crossbalance the revolving weights on the two outside crank pins, especially if they are set 120 deg. apart. For purposes of comparison, the weights given for the two-cylinder engine is used, which of course would not be correct since for two locomotives of the same power the one with three cylinders could have considerably lighter revolving and reciprocating parts. Also, it is assumed that the revolving parts of the inside crank with the back end of its main rod are completely balanced by the inside counterweights.* Referring to Fig.

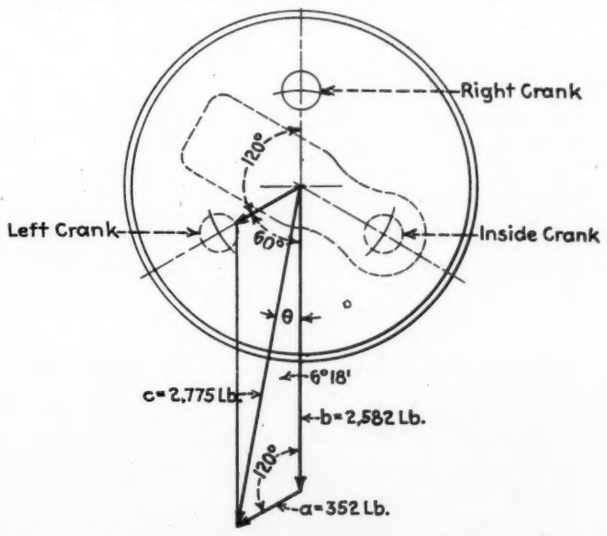


Fig. 7—In three-cylinder locomotives the cross-force works at an angle of 60 deg. to a line through the crank and axle centers

* This is not done in practice as it is not practical to place such large counterweights on the crank axle.

7, the cross-force is working at an angle of 60 deg. instead of 90 deg. to a line through the crank and axle centers and to combine its counterweight with the weight necessary to balance the adjacent crank we must use the cosine law:

$$c^2 = a^2 + b^2 - 2ab \cos 120 \text{ deg.}$$

Hence in our example

$$c = \sqrt{352^2 + 2{,}582^2 - 2 \times 352 \times 2{,}582 \times -\tfrac{1}{2}} = 2{,}775 \text{ lb.}$$

The amount of angle necessary is found according to the formula

$$\text{Sin } \theta = \frac{a}{c} \sin 120 \text{ deg.}$$

$$\text{Sin } \theta = \frac{352}{2{,}775} \times \cos 30 \text{ deg.} = .10989$$

$$\theta = 6 \text{ deg. } 18 \text{ min.}$$

In order to show that the effect of crossbalancing is more marked in the case of the three-cylinder than the two-cylinder engine, take the weights previously given for the two-cylinder engine and apply them here as was done before, with the exception that only 35 per cent of the outside reciprocating weights will be balanced instead of 50 per cent, as this is considered sufficient for this type of engine. Thirty-five per cent of 1,888 lb. is 660 lb., or 165 lb. to be placed in each driver. Since the revolving weights are 2,230 lb., the counterweight equals 2,395 lb. and as it is necessary to have 2,582 lb. for a perfect balance of one side, the unbalanced component equals 187 lb. If this 187 lb. is combined with the cross force of 352 lb. according to the cosine law, the resultant is 474 lb., which at diameter speed would produce a dynamic augment of 22,752 lb. The effective reciprocating balance would be

$$165 \times 3 - 187 = 308 \text{ lb., or } 16.3 \text{ per cent.}$$

By angling the balance and increasing its weight to 2,775 lb., then adding one-quarter of 308 lb., or 77 lb. per wheel, the weight of the main-wheel counterweight becomes 2,852 lb. The weight producing the dynamic augment is now 77 lb. and the augment is only 3,696 lb. Thus, by angling the balance and making it of the proper weight the augment is considerably reduced and the same percentage of reciprocating weights is balanced. Following usual practice, any part of the inside reciprocating weights is not balanced. Again it must be remembered that the revolving and reciprocating weights would be less than those chosen. The gain, however, would be proportionate.

In order to show what will occur with a three-cylinder engine of the same power as that of the two-cylinder given in the preceding example, reduce the area of the piston one-third and assume that the weights of the revolving and reciprocating parts can be reduced accordingly. This will make the weights as follows:

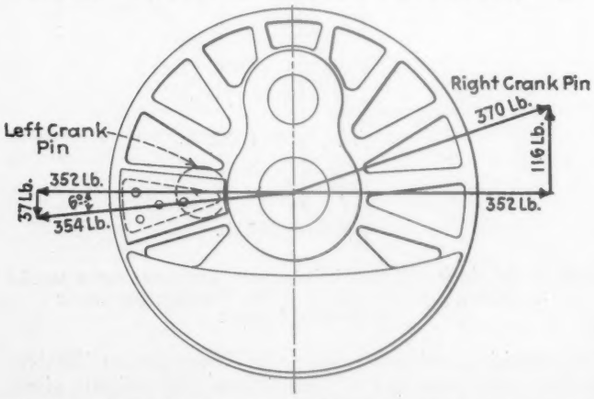


Fig. 8—Plates welded to two adjacent spokes, 90 deg. from the crank, and the space filled with lead reduces the augment in the main wheel

Reciprocating = 1,258 lb.
Revolving = 1,490 lb. = W_t

Overhang of revolving weights is reduced from 10 in. to 9 in. Using these values as in the preceding calculations:

$$W_e = \frac{72 \times 1{,}490}{63} = 1{,}700 \text{ lb.}$$

where 72 in. is the cross distance from the center of gravity of the total revolving weights hung on one crank pin to a reference plane through the opposite counterbalances, 1,490 lb. is the sum of the revolving weights on one main pin and 63 in. is the distance between the centers of the counterbalances.

$W_e - W_t = 210$ lb.
Reciprocating weights × 35 per cent = 1,258 × .35 = 440 lb.
Reciprocating weights for each driver = 110 lb.

Working this through with the ordinary method of balancing the main driver:

Counterweight at crank-pin radius = 1,600 lb.
Deficiency = 1,700 — 1,600 = 100 lb.
Cross-force = 210 lb.

$$\text{Resultant} = \sqrt{100^2 + 210^2 - 2 \times 100 \times 210 \times \cos 120 \text{ deg.}} = 278 \text{ lb.}$$

Dynamic augment = 13,344 lb.
Effective reciprocating balance = (110 × 3) — 100 = 230 lb. = 19 per cent.

For a crossbalanced condition:

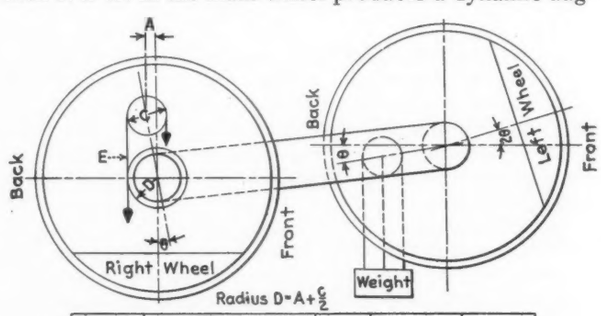
$$\text{Counterweight} = \sqrt{210^2 + 1{,}700^2 - 2 \times 210 \times 1{,}700 \times \cos 120 \text{ deg.}} = 1{,}815 \text{ lb.}$$

θ = the angle whose sine is $\frac{210}{1{,}815} \times \sin 120 \text{ deg.} = 5 \text{ deg. } 49 \text{ min.}$

Weight to be added to each wheel to produce 19 per cent effective reciprocating balance:

$$\frac{230}{4} = 57.5 \text{ lb.}$$

then 57.5 lb. in the main wheel produces a dynamic augment of 2,760 lb. If the static weight on the wheel is still 32,200 lb., then the per cent of main wheel rail loading added by the dynamic augment is reduced from 41.5 per cent to 8.6 per cent by crossbalancing.



Class	Weight to be hung on Crank Pin	A	Angle θ	Wheel
XX	1805	$2\frac{1}{32}$	7°46'	Main

Fig. 9—Method of crossbalancing the main wheel as used on the Santa Fe

Reducing the Augment in the Main Wheel

The augment in the main wheel of two-cylinder locomotives may be considerably reduced by the addition of a weight located at about 90 deg. from the crank pin, as shown in Fig. 8. This can be accomplished by welding plates onto the front and back of two adjacent spokes of the main wheel and filling the space between the plates and spokes with lead. The plates should be tied together with staybolts.

The main wheel of the two cylinder locomotive had 15 spokes and the diameter inside the rim was 58 in. It was calculated that a weight of 344 lb. could be placed between the two spokes immediately ahead of the counterbalance. This would make too heavy a weight since the distance from the axle center to the center of gravity of this weight was about 19 in. while the force to be balanced was only 352 lb. at the crank pin radius.

By filling the extra space with lighter material, the weight of this counterbalance could be reduced to 280 lb., which would be equivalent to 354 lb. at the crank radius. Due to the spacing of the spokes, the center line through this weight makes an angle of 96 deg. with a line through the crank and axle centers. The component of 354 lb. acting through the angle

96 deg. — 90 deg. or 6 deg. is 354 × cos. 6 deg. = 352 lb.,

which exactly balances the cross-force acting in this wheel. The component acting at right angles to this force is 354 × sin 6 deg. = 37 lb. Since this wheel was unbalanced by (2,582 — 2,466) = 116 lb., this can now be reduced by 37 lb., making the unbalanced force 79 lb., which would cause a dynamic augment of 3,792 lb. instead of the 17,760 lb. present before adding the second counterweight.

Method for Crossbalancing the Main Wheel

The method used by the Sante Fe and the one suggested by the A. R. A. committee for the shop forces to use in rechecking the main wheel counterbalances of a two-cylinder engine when it is crossbalanced is as follows: Place the pair of mounted wheels, with the crank pins in place on the regular level balancing strips. Suspend from the crank pin of the wheel being balanced the weight shown by the table below Fig. 9. The eccentric crank should be applied only to the wheel being balanced, in its correct position, with a weight equivalent to that of the back half of eccentric rod hung on the eccentric crank pin. The crank pin on the opposite wheel is to be bare. Scribe a circle on the end of the axle or hub on the opposite wheel with its center the same as the axle center and the radius equal to *A* in the table of Fig. 9, plus one-half the diameter of its side-rod crank pin journal. Hang a double plumb string from the side-rod journal and add or deduct lead from the counterbalance until the plumb string *E* hangs tangent to the circle with radius *D*, Fig. 9. Plumb string *E* is the back string when hung on the right crank pin and front string when hung on the left crank pin.

As a check, measure the horizontal distance between the axle and the crank-pin centers as denoted by *A*. When plumb string *E* is tangent to circle *D*, dimension *A* should be as shown in the table.

The committee also suggested the following method of calculating the weight to be hung on the crank pin of a two-cylinder engine which is crossbalanced. Referring to Fig. 9 and using the weights calculated for the engine given in the first example:

S = Stroke = 30 in. Crank radius = $\frac{S}{2}$ = 15 in.

θ = 7 deg. 46 min. 2θ = 15 deg. 32 min.
Cos θ = .99083
Sin θ = .13514
Cos 2θ = .96270
W_p = Crank-pin weight = 388 lb.
W_h = Crank-pin hub weight = 255 lb.
W_e = Eccentric-crank weight = 140 lb.
X = Weight to be hung on crank pin.
W_f = Final counterweight needed at crank radius and at angle θ as calculated before = weight necessary to balance the revolving weights plus a portion of the percentage of the reciprocating weights being balanced = 2,606 + 148 = 2,754 lb.

then

$$W_f \times \frac{S}{2} \times \cos 2\theta = (W_p+W_h+W_e+X) \times \frac{S}{2} \times \cos \theta + (W_p+W_h) \times \frac{S}{2} \times \sin \theta$$

$2{,}754 \times 15 \times .96270 = (388+255+140+X) \times 15 \times .99083 + (388+255) \times 15 \times .13514 \times 39{,}769 = 11{,}637 + 14.86X + 1{,}303$
X = 1.805 lb.
$A = 15 \sin \theta$ = 2.027 in. = 2 1/32 in.
C = 9¼ in. $\frac{C}{2}$ = 4⅝ in.
D = 4⅝ in. + 2 1/32 in. = 6 21/32 in.

In calculating the counterbalance, when the engine is crossbalanced, the weight of the main-wheel hub and its center of gravity must be calculated carefully, also the weight of each part of the crank pin encircled by each rod bushing must be calculated and added to the weight of the rod at that bushing.

[EDITOR'S NOTE: The following statement concluded the committee's report: "No tests were made to prove the conclusions arrived at in this discussion of crossbalancing, but the experiences of one road which has been using crossbalancing since 1924 and has made many tests for track and roadway stresses indicates serious deficiencies in the main-wheel counterbalances of locomotives balanced by the ordinary method which are overcome by crossbalancing."]

Duryea Underframe

(*Continued from page 445*)

conventional-underframe car with both couplers blocked; and one Duryea-underframe car without blocking behind the coupler and one conventional-underframe car with blocking behind the coupler.

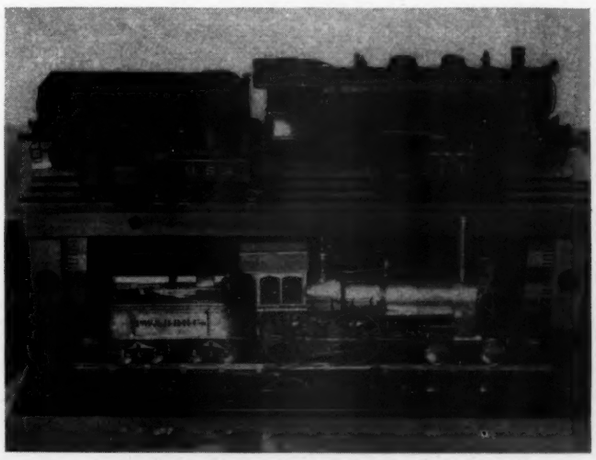
When using two cars equipped with the Duryea cushion underframe under double loading it took five impacts of the Duryea cars to distort the lading to a point where the cars were required to be shopped for resetting of bracing, while under identical conditions it only required four impacts to distort the lading to a point requiring the cars to be shopped for resetting of bracing on two cars equipped with the conventional underframes.

The results indicated that with any of the combinations of cars used on the tests, impacts at normal speeds can be successfully withstood.

The Baltimore & Ohio service records are said to disclose the fact that no cars equipped with the Duryea underframe have been shopped for repairs of any kind to the cushion gear, and that cars so equipped should last the life of the car and eliminate maintenance costs of draft gears, as well as materially reduce damage to lading and shopping of cars for repairs.

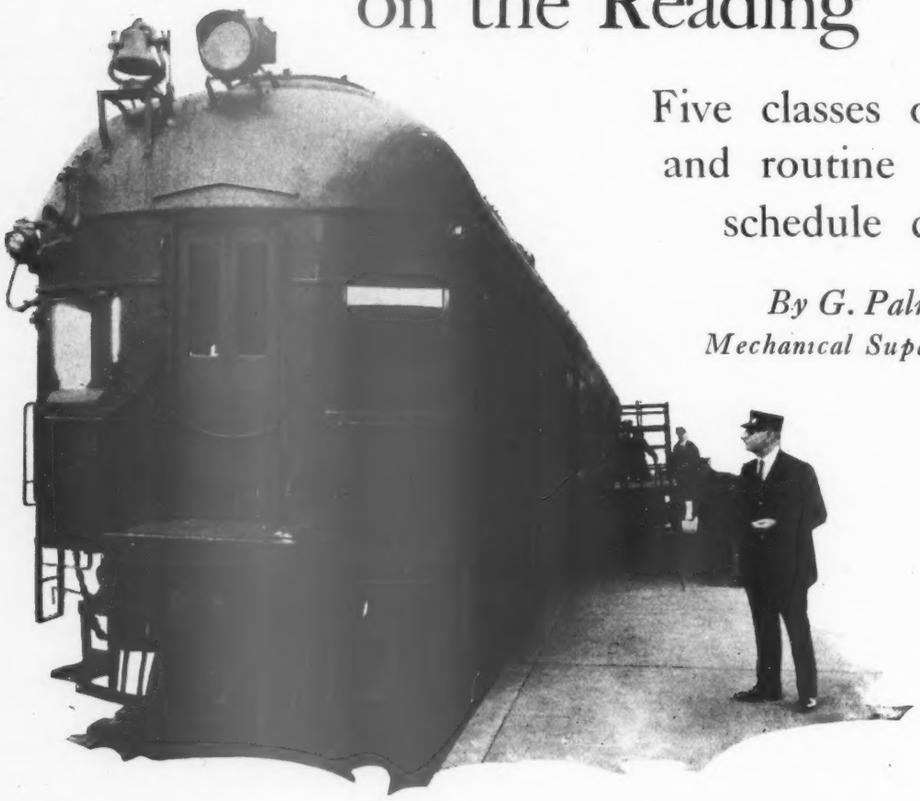
In addition to the cars which have been built for the Baltimore & Ohio, trial installations of the Duryea underframe have been made, or are in process of construction, on cars of five other railroads and four private car lines.

* * *



Part of the model locomotive collection of the late Samuel M. Felton, chairman of the board of the Chicago Great Western

Gas-Electric Rail-Car Maintenance on the Reading



Five classes of inspection and routine maintenance schedule developed

By G. Palmer Lerch
Mechanical Supervisor, Reading

THE development of the facilities and organization for maintaining rail cars and oil-electric locomotives on the Reading has resulted in a routine maintenance schedule and five classes of inspection each of which is based on the number of service miles completed by this type of equipment. These classes of inspection, which do not include a regular daily inspection of each unit, are designated as A, B, C, D and E inspections and are made at the completion of 1,200, 2,400, 4,800, 25,000 and 80,000 miles, respectively.

After each unit has completed 25,000 miles and 80,000 miles it is given a general overhauling either at the shops at Reading, Pa., or at the Trenton, N. J., enginehouse. At Trenton, a two-track building for housing four motor cars has been constructed. It is equipped with a crane, a pit track, a small machine shop and valve grinding and carbon cleaning equipment. No extra facilities have been provided at the Reading shop for doing this work.

The home terminals of several of the cars are at outlying points. When the rail cars were first placed in service, a number of these points had enginehouse facilities, while at others no maintenance facilities of any nature were available. Refueling facilities are now available at all home terminals and several of these have underground fuel tanks of approximately 12,000 gal. capacity and motor-driven fuel pumps with capacities ranging from 15 to 20 gal. per min.

The engineer of motive power, under the direction of the superintendent of motive and rolling equipment, is charged with the general supervision of rail cars and oil-electric locomotives. The men chosen to maintain the equipment are selected from the regular enginehouse forces and all maintenance work falling under inspection classes C, D and E is completed at the home terminal point of each car. When a new car is purchased, a service representative of the builder remains with it from 15 to 30 days. This representative instructs the workmen in the regular inspection, adjustment and maintenance work.

At points where electricians are not available, one man maintains both the engine and electrical equipment on the unit assigned to his care. Other work on the cars, such as air brake, trucks, etc., is taken care of by the

Interior of the shop at Trenton, N. J.

regular enginehouse or shop forces. At a number of points, such as Slatington, Pa., Coatesville, Pa., Tuckahoe, N. J., Cape May, N. J., and West Milton, Pa., one man is assigned to do all the light running-repair work on the cars. All work in the engine room and on motorized trucks is attended to by the enginehouse employees. Other work on the cars, such as non-motorized trucks and regular car-body work, is assigned to the car-department employees. Cars are refueled by the roundhouse force and the motor-car crews at one to three day intervals, depending upon the capacity of the car fuel tanks and the number of miles operated per day.

Daily Inspection

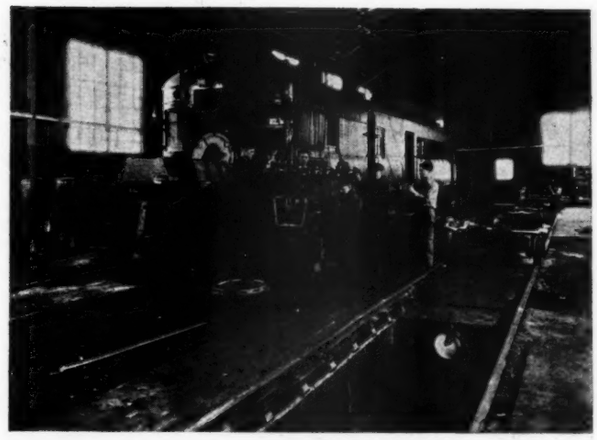
Two to four hours are required for the daily inspection of each car, depending on the size of the unit and on the condition of its equipment. However, if adjustments must be made, this time is increased. The following work is attended to during the daily inspection: The oil pressure is checked when the engine is hot, both at idle speed and open throttle, as soon as car arrives at the terminal. The oil level in the crankcase, the firing of the spark plugs, the water level in cooling system are checked and the latter is inspected for leaks. The water in gasoline strainer cups is drained. Grease cups on the generator, the fan motor, the fan drive shaft and the water pump are turned down. The batteries are checked and a general inspection of the electrical equipment, such as generator commutators, switches, relays, contactors and brushes is made, looking particularly for loose connections, dirt, pitted contactors and commutators.

The regular air-brake inspection is made and, in addition, the work reported by the engineman and that found as a result of the inspection is performed.

Class E Inspection—1,200 Miles

In this class inspection the following work is performed in addition to the daily routine inspection: The spark plugs are removed, cleaned and the points are reset. The valve clearance is checked while the engine is hot. The oil level in the engine governor is checked and the magnetos are oiled. The grease cups on the engine-speed tachometer are filled and screwed down. The bolts on the entire engine, including those on the manifolds, magneto brackets, etc. are all tightened. The engine is checked completely for oil leaks and the sediment accumulated in the bottom of the vacuum tank is drained off. The gasoline vacuum line is checked for tightness. The coupling bolts and studs between the generator and the engine are inspected and tightened. The throttle and spark-control shaft bearings, mounted on engine, are thoroughly oiled and are examined for loose or worn parts and for free movement.

The oil level in the traction-motor armature and axle bearing wells and the lubricating compound in the gear case are inspected. The air gap between armature and field poles is checked. The brushes are removed and cleaned, the brush holders are cleaned and examined for broken porcelain and the brush tension is adjusted. The armature and field windings are inspected for oil and dirt and cleaned if necessary. The motor is examined for loose parts, and cable and leads for chafing. The motors are blown out with compressed air and the motor commutators are examined for roughness or pitting.



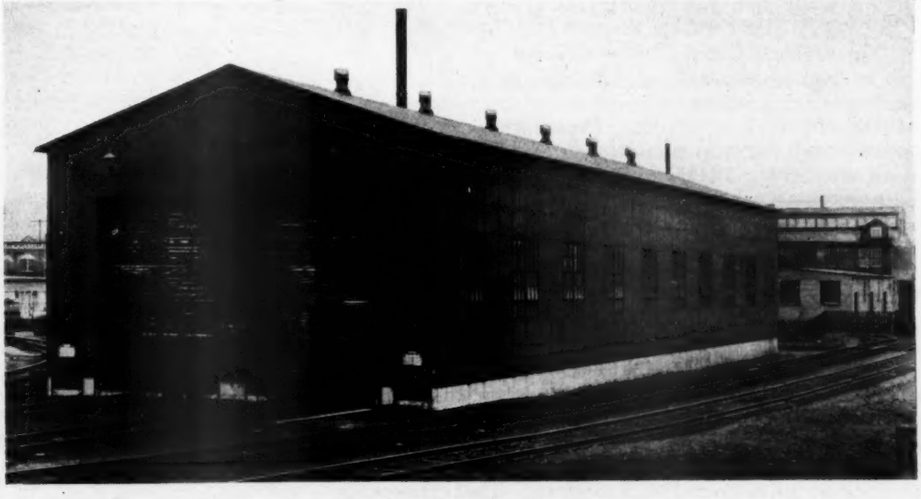
Replacing the crankshaft in a Brill-Westinghouse engine

The condition of the generator brushes is checked and the commutator is examined for rough or pitted condition. The terminal connections are checked for tightness and cleanliness. The commutator of the fan motor is also examined for roughness or pitting.

The toggle switches, line switches, contactors and relays of the control system is inspected, cleaned and adjusted. The tension of all interlock, reverser and controller fingers is checked and these parts are cleaned and lubricated. All leads are examined for loose connections. The electro-pneumatic throttle-operating mechanism is inspected and lubricated. The oil level of the air compressor is checked and its commutator is examined for roughness or pitting.

Class D Inspection—2,400 Miles

In addition to the work completed under Class E inspection, the following work is performed: The oil in the crankcase and oil filtrator is changed. The brush holders and distributors of the magnetos are cleaned



The motor-rail-car shop at Trenton, N. J.

Valve-reclaiming tool in use at the Trenton shop

and the breaker points cleaned and adjusted if necessary. The magneto coupling is inspected and examined for loose bolts. The motor-nose suspension at the truck-frame transom is examined. All electrical parts of the air compressor and the traction motors are carefully examined.

All electro-pneumatic control units are tested and lubricated and the air valves are cleaned. The operation of the throttle is checked from both ends of the car and also from the trailer cars to determine if the carburetors open fully.

Class C Inspection—4,800 Miles

All work specified in Class D inspection is performed in addition to the following: The compression

Reading Self-Propelled Cars

No.	Type	Car Builder	Engine	Total hp.	Elec. Equip.
2	Mechanical	J. G. Brill	Midwest	68	.....
3	Gas-electric	J. G. Brill	Brill-Westinghouse	500	West. torque
2	Oil-electric	Bethlehem	Westinghouse	330	West. torque
2	Gas-electric	Bethlehem	Mack	405	G.E. dual differential
2	Gas-electric	J. G. Brill	Hall Scott	600	West. torque
1	Gas-electric	J. G. Brill	Brill-Winton	330	West. torque
1	Gas-electric	Cummings	Mack	360	West. face-plate torque
4	Gas-electric	J. G. Brill	Brill-Westinghouse	250	West. differential

Eight light-weight trailers operate with this equipment.

of the engine is checked. The oil-pan nuts are examined and the drip pan is cleaned. The oil filtrator is cleaned every 10,000 miles or during alternate class C inspections. The gasoline strainer bowl is removed and the screen is cleaned. The armature and axle bearings of the traction motor are inspected and the waste loosened if necessary. The brush tension of the generator and fan motors is adjusted.

Class B Inspection—25,000 Miles

All work as required in Class C inspection is completed and in addition the following is performed: The cylinder heads are removed, the valves ground and the carbon cleaned. The pistons are removed and new rings are applied. The cylinder sleeves are checked for being out-of-round and tapered. The connecting-rod bearings are inspected for cracks, looseness on dowels, etc. The oil screen in the lower half of the crankcase is cleaned and all oil lines, oil ports and passages in the crankshaft, connecting rods, etc. are thoroughly cleaned and inspected. The oil vacuum pump is inspected and cleaned. The clearance on the cam-shaft bearings is checked and a general inspection is made.

The waste at the armature and axle bearings of the traction motor is removed and new applied. The wear of the thrust-bearing portion of axle-bearing lining is checked and all motor leads, wiring and connections are inspected. The generator, motor and all electrical apparatus in the control and switch cabinets is blown with compressed air, cleaned and adjusted.

Class A Inspection—80,000 Miles

The Class A inspection covers a general overhauling of the engine, its accessories and all electrical equipment. In addition to the work completed under class B inspection, the following is performed: The engine is removed from the car and completely torn down. The crankshaft is removed, the main bearings are thoroughly checked, all parts are carefully micrometer checked and the limits of wear specified by the engine builders are strictly adhered to. The generator is removed from the car. The exciter and armature are removed and all parts are thoroughly cleaned with air and gasoline and checked for shorts and grounds. The insulation is then examined for cracks. The armature and field windings are then painted with insulating varnish and allowed to air dry for 36 hours. The commutator is machined or smoothed up and placed in first-class condition. This same work is performed on the traction motors, the blower motor and the air compressor. All other electrical equipment is thoroughly cleaned and adjusted. All wiring and insulation resistance is measured by a megger.

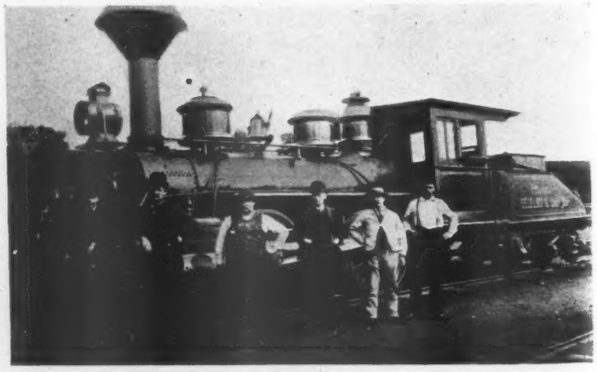
Oil-Electric Rail Cars

The above maintenance schedules are followed out in general on oil-electric cars, with certain modifications which apply to a Diesel engine.

Through experience it has been found that if the above maintenance schedules are followed out, a high availability of service from motor rail cars can be expected and no undue trouble should be experienced in the maintenance of this type of equipment.

The average availability of all motor rail cars on the Reading for 1929 was 92 per cent. One of the cars had an availability of 100 per cent and two of the cars had an availability of 97.25 per cent.

* * *



From collection of Geo. M. Sittig and Jos. Lavelle

Pittsburgh, Shenango & Lake Erie switch engine "Shenango"

EDITORIALS

High Water Increases Maintenance Costs

IT is a well-known fact that the practice of carrying the water high in the boiler of a locomotive is the cause of failure to piston packing, cylinders, guides, pistons and superheater units. Nevertheless, little attention is given to the subject in the instruction of enginemen and it is frequently overlooked in the routine duties of the enginehouse foreman. One road in the east has been making a special effort during the past few months to instruct its enginemen in carrying water at the correct height. Reports recently received indicate that a big improvement has been made on the part of all enginemen on the road in correcting this bad practice, and there has been a reduction in repairs and shop expense in the maintenance of locomotive parts affected by high water.

Obsolete Machines and Locomotives

ABOUT 35 per cent of the locomotives belonging to steam railroads are said to be over 20 years of age and consequently were built before the general introduction of such well known capacity—and economy-increasing devices as the superheater, feedwater heaters, locomotive stokers, thermic syphons, etc. Seventy-nine per cent of the country's steam motive power is over 10 years old, or, in other words, antedate many of the present refinements and improvements in locomotive auxiliary devices.

While not new, a thought well emphasized by George H. Houston, president of the Baldwin Locomotive Works, in an address before the Western Railway Club in March of the present year, was that this relatively long life and delayed retirement of steam locomotives constitutes a serious drain on the railroad treasury, owing to the slowness with which thoroughly-tested improvements are applied to the great mass of motive power. Obviously, the more rapid the turnover of power, the sooner railroads will be able to capitalize on improvements which have demonstrated their ability to effect economies.

Analogies drawn between equipment in railroad and in other industrial fields are interesting, if not always suggestive of what may be accomplished with the railroad equipment. Referring to the power plant and shop machinery fields, for example, Mr. Houston said: "In our public utility companies, there is little prime mover equipment now running, other than for standby service, that is in excess of 10 years of age; and in the high-pressure machine shops of the country there is little production machinery now in use that was in existence at the close of the war. For instance, General Motors Corporation is actually replacing its machine tool equipment in the majority of its divisions on the basis of a five-year life, due to obsolescence of design."

In the field of motor trucks and coaches also, this same principle is found exemplified. The average life of a truck or motor coach is about five years, or but a small fraction of that of a locomotive. This may be explained as due to a realization on the part of the truck operator that his truck will be entirely out-of-date and obsolete in a period of about five years, anyway, and he may just as well work it to the limit during that period and thus realize the maximum return on his investment.

Regarding obsolescence, Mr. Houston says: "As a machine reaches a certain stage of obsolescence of design, it should be discarded and renewed for reasons of economy of operation regardless of the fact that as a mechanical device it will still operate with much of the effectiveness it possessed when new. Even if new, it would be unfit for present day use. It appears sound to believe that this policy of dealing with obsolescence can and should be applied to locomotives with the same successful results which have already been experienced in other fields of mechanical equipment. The very foundation upon which our mechanical arts have been developed in America has been the courageous elimination of the obsolescent in favor of the modern with the consequent advantages to be derived from the use of the most improved facilities."

Improvement in design renders steam locomotives obsolete in just the same way, if not in the same length of time, as it does power-plant prime movers, machine tools and motor trucks. The specialization of steam motive power for particular service requirements also shortens the average effective service life of locomotives. The question may be asked: What is going to become of these locomotives which are made out-of-date by improvements in design and by changes in traffic requirements? The answer proposed by Mr. Houston, and which seems a logical one, is to use motive power intensively, load it to capacity and get full value from the investment in the shortest possible period of time so that the locomotives can be replaced just as soon as additional improvements or further changes in conditions furnish sufficient justification.

Waste Grabs - A Cause or Result?

A LETTER appears on the "Reader's Page" of this issue which gives some interesting facts pertaining to the much discussed hot-box problem. The writer, J. P. O'Connor, of the Missouri-Kansas-Texas, states "it has been proved beyond doubt that many hot boxes are the result of waste grabs." He goes on to state that "in most cases waste grabs are caused by the jar in passing over track crossings."

Waste grabs are also caused by rough journals, thick oil, which causes shreds of waste to stick to the journal, and by improper packing of boxes. A hot box may be caused by a waste grab which, in turn, is caused by some mechanical or lubrication defect. Therefore, to report a hot box as being caused by a waste grab does not mean anything, and is of no assistance in analyzing the hot-box situation. The report should show what caused the waste grab.

Reports from one railroad show that as high as 80 per cent of the hot boxes are caused by waste grabs.

Likely that railroad will continue to have a large percentage of hot boxes charged to waste grabs if the inspectors are permitted to get away with it. If car inspectors are instructed to keep in mind that hot boxes apparently caused by waste grabs are the result of some other primary defect, and to report the original defect as the cause rather than "waste grab," the railroads will find themselves in possession of records which should be of real assistance in the solution of the hot-box problem.

A Word about Stabilization

WITH equipment maintenance work and forces cut to the bone, if not to the marrow, many will consider it a waste of words to talk about stabilization. It is still true, however, that the stabilization of mechanical department operation and forces offers possibly the greatest single opportunity for improvement in railroading, and present conditions serve only to emphasize that fact. The great need now, as always, is for railroad executive officers who are "mechanically minded" and view equipment maintenance work on a yearly rather than a monthly basis. At least equally important is the urgent need for more mechanical officers with sufficient vision to see in all its details how much the ups and downs of mechanical work are costing the railroads and with sufficient backbone and persistence to keep hammering the facts home until their respective managements are convinced. Evidence is not hard to find that a condition of deferred maintenance, particularly as relates to car equipment, is responsible even now for the failure of car and locomotive parts with the attendant train delays, increased operating expense and dissatisfied shippers. In addition, uncorrected minor defects pyramid and, when finally attended to, result in excessive repair costs which must be balanced against a temporary saving in monthly operating expenses. By all means, let us have more, and not less, discussion of mechanical department stabilization. The *Railway Mechanical Engineer* is pleased to note that this subject will be presented in what promises to be a highly informative and instructive committee report before the International Railway General Foremen's Association at its annual fall convention at the Hotel Sherman, Chicago, September 16 to 19, inclusive.

A. R. A. Joins American Standards Association

THE announcement on the first of June that the American Railway Association had joined with a number of other industrial associations, engineering societies and manufacturing associations in the underwriting of the American Standards Association is gratifying. This official action on the part of the A. R. A. is evidence of the fact that the association is fully alive to the close relationship of new development in the fields of transportation to developments in other industries.

The objects of the American Standards Association are to provide a systematic means of co-operation in establishing American standards to the end that duplication of work and the promulgation of conflicting standards may be avoided; to serve as a clearing house for information on standardization work in the United States and foreign countries, and to act as the authoritative American channel in international co-operation in standardization work. This program coincides especially well with the work that the Mechanical Division has been doing with respect to the standardization of freight cars and other mechanical equipment. The Engineering Division, A. R. A., has been a member of the A. S. A. for a number of years. Although the railroad industry has been represented on many committees of the American Standards Association in past years, either by appointments made unofficially through the Mechanical Division or by appointments of mechanical engineers employed in the railroad or railway supply industries, by societies such as the American Society of Mechanical Engineers, there is no question but that railroad representatives on the various committees of the A. S. A. will find their work easier and their opinions bearing considerably more weight because of their official status as representatives of the A. R. A.

More Thorough Wheel Work

AS a runner needs, first of all, strong legs, the primary requisite in a locomotive is a set of strong, properly-designed and accurately-maintained driving wheels. Rail wear, flange wear, hot boxes, accidents, train delays and excessive operating expense—all are occasioned by the lack of proper attention to this detail of locomotive construction.

Recognizing the vital part which driving wheels play in locomotive operation, a number of roads are giving special care to the handling of wheel and box work in the back shop, and, among others, the St. Louis-San Francisco has made notable progress in raising its general standard of driving wheel maintenance. The method used is simply to get back to fundamental blue-print dimensions, checking all details of the tire, wheel center and axle assembly, and making no assumptions that, because certain wheels have already been in service, they necessarily conform to the railroad standards.

There are many variables in the driving-wheel assembly which, either singly or in combination, are bound to introduce errors without the greatest care on the part of inspectors and maintenance forces in both back shops and enginehouses. For example, under the great stress occasioned by shrinking tires on wheel centers, a certain amount of dishing is inevitable, this action being accentuated in wheels of large diameter. Consequently, the tires, shrunk on wheel centers accurately machined in the first place, may be out of gage after cooling. The wheel shop foreman is confronted with two alternatives. He may make allowance for this movement of the wheel rim in setting the tire, or a light cut may be taken over the tire after application to the wheel center. No doubt, some roads would consider it a waste to put driving wheels with new tires in the wheel lathe again for a light skimming cut, but this is the general practice on the Frisco and is one very good way to make absolutely sure that the tire flanges and treads are true and in accurate gage.

Not only is the location of driving-wheel tires on the wheel centers important, but the methods of checking hub wear and lateral deserve the most careful scrutiny. Many a locomotive has gone out of the back shop with lateral play unequally divided on one pair of wheels and consequent forcing the flanges of this one against the rail, causing rapid cutting of the flange, as well as several reams of correspondence, to mention only one item of resultant expense to the railroad.

The importance of constant check to assure the accuracy of driving wheels was strikingly demonstrated on a railroad not long ago when a depression in the main wheel-center rims on either side of the crank pins, between the pin and the counterbalance was discovered. The class of locomotives which had been reported pounding was designed for use in heavy freight service, and the counterweight on the main wheels was unusually large, occupying fully 50 per cent of the area of the wheel. The crank pin also was large so that the wheel center was almost solid except for two spokes on either side of the crank pin, which, with a light rim section, constituted the weakest point in the wheel design. Initial stress in these spokes and rim, supplemented by a tire-shrinking stress and the hammer blows encountered in passing over rail joints, frogs and switches in road service, apparently exerted an upsetting action on these spokes and the rim to such an extent that the latter was depressed from 3/32 in. to 3/16 in. from a true circle on either side of the crank pin. Tests are said to have shown that even a new 3½-in. tire, when shrunk on this inaccurate wheel center, conformed to the inaccuracy of the wheel center rim and resulted in a pound on the rail. The method used for solving this difficulty was to build up the depressed rim with electric welding and turn it accurately to standard blue-print size.

The instance cited simply serves to emphasize the responsibility of the wheel-shop foreman and wheel maintenance gang in turning out locomotives in condition to give satisfactory performance.

Standard Practice in Locomotive Maintenance

THE secretary of a western railroad's standard practice committee, the duties of which are to standardize the various items of locomotive maintenance and repair work, said recently that one of the most tangible results obtained from such practice was the decrease in the number of engine failures. The mechanical superintendent of this road reported that his power had run a total of 35,182 miles per engine failure in 1924 while in 1929 the figure had been increased to 113,097 miles.

Rigid inspection and running-repair maintenance in compliance with standard practice instructions has probably been one of the greatest factors in producing this record of improvement. Of equal importance is the matter of standard practices adhered to while locomotives are undergoing repairs in the back shop. Standard practice instructions are furnished to all employees concerned. These instructions cover materials, facilities and general procedure for repairing locomotives and their appurtenances and must be strictly followed. No deviation from the instructions are tolerated and in case any questions arise as to such instructions, the matter is taken up with the mechanical superintendent and no changes made until proper authority has been secured.

With rigid instructions of this nature covering the repair work in the shop the quality of the work must necessarily be high. This is supplemented by the fact that on this same road, 62 per cent of the locomotives inspected by federal inspectors in 1924 were found defective while in 1928 this figure was reduced to three per cent.

NEW BOOKS

MECHANICAL WORLD YEAR BOOK, 1930. *Published by Emmott & Co., Ltd., 65 King Street, Manchester, England. 180 pages, Illustrated. Price, 1 shilling six pence.*

Several new sections have been added to this 1930 edition of the Mechanical World Year Book. The sections on steam engines, steam turbines, condensers and rope driving have been revised and rewritten, and the latest steam tables incorporated. This hand book contains information and data on British and European practice.

MARKS' MECHANICAL ENGINEERS' HANDBOOK.—*Editor-in-Chief Lionel S. Marks, professor of mechanical engineering, Harvard University. Published by the McGraw-Hill Book Company, Inc., 370 Seventh Avenue, New York. 2,264 pages 4½ in. by 7 in. Bound in leather. Price $7.*

In accordance with the purpose of the first and second editions of the Mechanical Engineers' Handbook, Marks' third edition provides the mechanical engineer with the theory and data necessary to keep him abreast of current practice. Theoretical discussions have been strengthened and a new section added on the subject of vibration. Standards and practice have been brought up to 1930; physical data have been revised, and a number of new subjects, such as industrial combustion furnaces, electric furnaces and high- and low-pressure carbonization of coal, covered. The size of the book, which now represents the work of over seventy specialists, has been increased by about 270 pages. Thumb-tab and alphabetical indexes provide a ready reference to the thirty-three major topics covered in the sixteen sections of the book.

THE ALUMINUM INDUSTRY. *By Junius David Edwards, assistant director of research; Francis C. Frary, director of research, and Zay Jeffries, consulting metallurgist, Aluminum Company of America. Published by the McGraw-Hill Book Company, 370 Seventh avenue, New York. Two volumes, illustrated. Price, $12 per set.*

The first volume of this set, which is entitled "Aluminum and Its Production," covers the history of the discovery of aluminum and the development of the industry, the ores of aluminum and their mining and refining for the production of pure alumina, and concludes with a discussion of the production of metallic aluminum. The general treatment of the subject is along broad lines, except in regard to the production of alumina from the ore, which has been treated in greater detail because of the widespread interest in the production of alumina. The second volume is sub-titled "Aluminum Products and their Fabrication." It discusses the properties of aluminum and its alloys, the fabrication of aluminum products and their uses in the industries. Both volumes are well documented with references to patents and various scientific and technical publications in both Europe and America. In addition, Volume I closes with an appendix setting forth a list of books about aluminum and its alloys and several chapters in Volume II close with extensive lists of references to the literature dealing with the constitution and structure of aluminum alloy systems, properties of alloys of aluminum with other metals, and commercial alloys of aluminum. The books form a part of the Chemical Engineering Series.

THE READER'S PAGE

Thin Journal Bearings and Loose Wheels

WORCESTER, MASS.

TO THE EDITOR:

HOW thin will a bearing become before it is apt to cause a hot box? In my opinion a car repairman would have to carry a pair of calipers for gaging thin bearings if the A.R.A. established a condemning rule limiting the thickness of journal bearings.

I would like to see an article in the *Railway Mechanical Engineer* on the subject of loose wheels. I have seen cases where wheels showed evidence of being loose and still, after being removed from under the car, they are not loose. Does a wheel have to move on the axle after it has been removed from under the car as proof that the wheel is loose, or is there a possibility of it being sufficiently tight on the axle to deceive the car repairman? Steel dust and oil appearing on the inside of the wheel fit are well known indications that the wheel is loose on the fit. However, I would like to hear from some other readers on this subject.

A READER.

Some Facts on the Hot-Box Problem

PARSONS, KAN.

TO THE EDITOR:

Considerable has been published in recent issues of the *Railway Mechanical Engineer* relative to the hot box problem. For that reason, in line with what has been said, I am submitting some facts and suggestions with the hope that they may be of some assistance to those who are making a special study of this problem. The following gives the number of cars shopped at one point on this road for wheels, cut journals and other defects for the months of February and March of this year:

	February 1930	March 1930
Total number of cars shopped for wheels	124	111
Number of cut journals	74	70
Shopped for wheels with other defects	50	41
Of the cars shopped for cut journals there were:		
Private line tank cars	44	38
Private line refrigerator cars	6	2
Railway owned cars	24	30
	74	70

In addition to the preceding figures, data obtained several months prior to February at the same point showed that the average number of cut journals varied little from the figures shown for the months of February and March.

I have observed the condition of journal boxes, and packing removed during a period of several months and have found that nearly all of these cut journals have air-tight journal boxes. On the other hand, I have observed many cars which were heavily loaded which had loose box lids and some lids missing. I cannot recall a single instance of any of these cars being shopped for cut journals. Can it be that a little ventilation will eliminate a large portion of these cut journals?

It has been proved beyond doubt that many hot boxes are the result of what is known as waste grabs, where a shred of the packing has worked up under the brass. In most cases, waste grabs are caused by the jar in passing over track crossings. Is there not some way of holding this packing in place and reducing this menace?

I have discussed this matter a number of times with men of many years experience in car work and some have suggested changes in the system of packing. Others have suggested that some type of weight be used to keep the packing from working up too close to the brass, while others suggest more ventilation.

J. P. O'CONNOR,
Write-Up Clerk, Missouri, Kansas & Texas.

Our Imaginary Car Shop a Poor Investment?

CLEVELAND, OHIO.

TO THE EDITOR:

I have read with considerable interest the article in the June issue of the *Railway Mechanical Engineer* entitled "Modernizing a Car Repair Shop."

To a great many of the writer's remarks I can heartily subscribe. It is very easy to understand Oliver Carson's desire to get a new car shop with all of the equipment which he describes. But I am wondering if he really took advantage of the facilities which were already available. I think not. Using the words of the famous character of Chic Sales, "I am going to tell you the reason why."

Realizing that the condition is probably as imaginary as the writer led us to believe, I am going to work along the lines that he imagined a lot of his troubles instead of digging in to determine if there was an inexpensive way out. He, like many car foremen, was up against a tough piece of going and threw up his hands and quit.

At the present time I know a little job where 14 car repairmen, including three apprentices, are repairing 1.2 U. S. R. A. 55-ton all-steel hoppers each day, and not on the progressive system either. These cars receive 100 per cent renewals of side and end sheets, slope sheets, cross hoods, center ridges, inside and outside hopper sheets, hopper doors and miscellaneous items. In addition, all of the posts and plates are removed, straightened and reapplied to the cars. Quite a large number of the cars have bent center sills and these sills are cut apart and straightened. All of these operations, except the removal of posts, are performed in three positions on four car spaces of room. The cars are stripped to the center sills by three men on a stripping track. This track is located some distance from the repair track. The center sills, after leaving the stripping track, are sand blasted and sent to the erection track. The parts removed from the car which are to be repaired are sent to the reclaiming shop by gasoline tractor. Scrap parts are loaded in scrap cars on the stripping track and O. K. parts loaded on the frame and go to the erection track with the frame.

The work is performed in the open. The first posi-

tion of the car is a fitting position, and the heavy parts are lifted into position with an air hoist of 500 lb. capacity. The car is then moved to a riveting spot. The trucks are repaired and at the next space the car is trimmed. The fourth space is for storage of completed cars which are switched out each night and set for sand blasting and painting.

Now with 14 men handling this sort of operation, 119 men can, and should, repair nine cars per day, or 54 cars a week on the 44-car track space available in the "imaginary old shop." As a matter of fact, the force could be reduced from 119 to probably 100 and this production secured on a set-up similar to that described, but on a larger scale.

In this same shop 750 composite 55-ton hoppers were completely rebuilt recently with 30 to 32 car repairers, with an assigned output of three cars per day. Frequently, for several days at a time, 3.5 cars per day were repaired. This job was handled on four tracks holding five cars each, dead end if you please, and no "straight line" movement of cars. In this case, too, the cars were stripped on these four tracks and the force included the strippers; no overhead cranes, hoists or anything of that kind.

The steel for these cars was purchased fabricated, but Oliver Carson is not intending fabricating either, so the story says. (Why all the machinery?)

It hardly seems possible that the story was written in a serious vein. As a story covering all of the tools that might be used in a car shop, it is all right, but it is as full of holes as Swiss cheese. You certainly cannot get your readers to believe that any railroad executive would permit himself to be kidded in this manner, so why kid yourself with such imaginary tales? The pitiless light of actual facts will certainly show up the unfamiliarity with which Mr. Allen treated his subject.

C. E. Loyd.

Labor Limits in A. R .A. Rules Are Too High

To the Editor:

The labor limits in A. R. A. Rule 120 have been reduced considerably in the past few years, but nevertheless there is need for further reductions. In view of A. R. A. Rule 3, Section u, Item 2, it does not appear to me that Rules 3 and 120 are working in harmony with one another. In rule 120, we find that a car of all-wood construction may be repaired by the handling line to the extent of from $40 to $100 labor, excluding cars of less than 60,000-lb. capacity and repairs to trucks. This does not, of course, take into consideration the cost of material which is in some cases 75 per cent of the cost to repair a damaged car. A handling line in most cases does not wish to make heavy repairs to obsolete equipment without making any betterments, but under the present A. R. A. rules and per diem rules it has no other recourse unless the car is located at a junction point that has a direct connection with the car owner.

The same conditions exist when cars are subject to Class E-4, Rule 112, as defined in Rule 3, Section u, Item 3. Cars of this class must be out of service by January 1, 1934, or rebuilt. The labor limits for cars of all-wood underframe equipped with draft arms extending to the bolster only and for cars of wood underframe equipped with draft arms extending back to the bolster are given in Rule 120, Section b. It does not seem reasonable that it was the intent of the rules committee that this rule be so stringent.

It is hardly fair to a car owner to allow the delivering line the right to make such extensive repairs as is now its privilege under the existing rules. The rule as now written makes no provision for the age of the car. Cars one or 20 years old, if of the same class, are subject to the same labor limits in Rule 120. The fact that a car has been rebuilt or not, is not taken into consideration.

In view of the large building and rebuilding programs of cars that are now in progress on the railroads, it would be apparent that the age of cars should be a considering factor when deciding the labor limits in Rule 120. A graduated labor limit could be used in conjunction with this rule, the labor limits decreasing at least 10 per cent per year from the date that the car was built new, or was rebuilt. This scale to be used from a stated maximum down to a given minimum labor limit.

In many cases a car foreman will estimate the damage to a car and find that it is close to the labor limit, but does not exceed it. This car will be repaired, and when the repair card is priced it will show that the labor limit was exceeded by at least $10 or $15. The handling line must, of course, assume this oversight as well as a percentage reduction in material. The rules provide for cars that are reported under Rule 120, a limitation of $50 above the total estimate. This rule should allow for an under-estimate as well as an over-estimate. If a car is reported under Rule 120 and if, after repairs are made, it is found that the labor limit did not exceed the prices in Rule 120, the handling line must assume the per diem that was waived when this car was reported under Rule 120. If an under-estimate was allowed, say five per cent of the labor limit, it would provide for cases of this kind. It is usually the practice, in view of the above sentence, when a car runs close to the labor limit, to repair a car without reporting it under Rule 120. This condition accounts for the cars that are repaired with the labor limit exceeded. In nine out of ten cases where a car is reported under Rule 120, if the car is 15 years or more old and not rebuilt, the owner will authorize the dismantling of the car.

The correct interpretation of the last sentence of Rule 1, Section b, should be that if the total damage to a car and all necessary repairs otherwise do not exceed the labor limit as per Rule 120, the minimum repairs necessary for safety to trainmen and lading should be made. More stress should be made in this rule, that if the total cost of labor to all necessary repairs exceeds the labor limit, the car should be reported to the owners for disposition. This rule should not be construed to mean that the delivering line may make such repairs as are absolutely necessary to move the car, which in some cases incurs an expense of several hundred dollars, when at the same time they will overlook decayed and corroded parts that will have to be repaired when the car reaches home. The total damaged parts and all other necessary repairs should be taken into consideration in an estimate, so that if the total labor cost to put the car in first class condition exceeds the labor limit, it will be necessary to report the car to the owners for disposition.

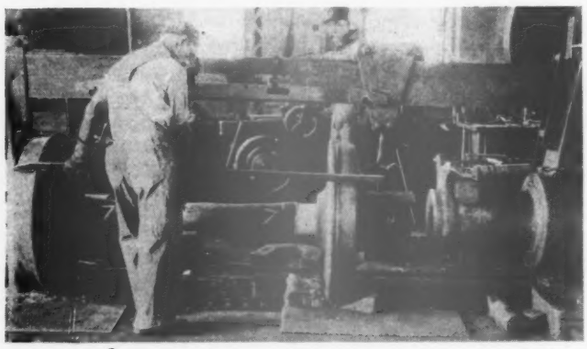
It is a waste of money to spend several hundred dollars on an old car knowing that the car owner will have to rebuild or dismantle the car when it is received home.

James McDonnell.

With the Car Foremen and Inspectors

Wheel Press Improvements

IN the wheel shop of the Denver & Rio Grande Western at Denver, Colo., it was found necessary to replace the blocks on the wheel dollies of the wheel press. Grooves were cut in the new blocks, to the contour of the wheel flange and tread and the entire block covered with ¼-in. plate, bolted in place. This brought the flange groove flush with the floor and made the set of

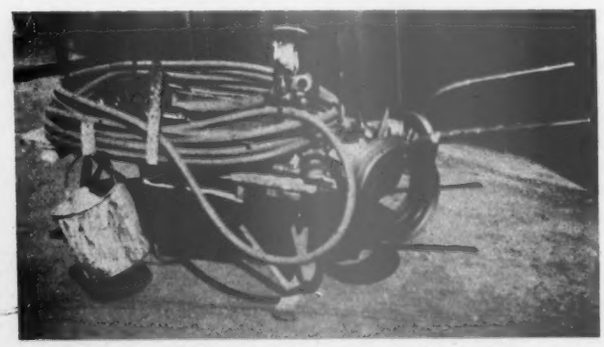


The wheel dollies of the press are fitted with ¼-in. plate to bring the flange groove flush with the floor

blocks more efficient and durable. Another improvement in the press consists of two double hooks of flat iron, hung on the beam of the press, to hold the gages where they are always handy.

Compact Air-Outfit for Yard Service

THE air-outfit for yard work shown in the illustration is built on the chassis of a conventional all-metal wheelbarrow, the body having been removed and a flat wooden floor substituted and bolted to the



The outfit carries all equipment necessary to work the air on a car in accordance with Rule 60

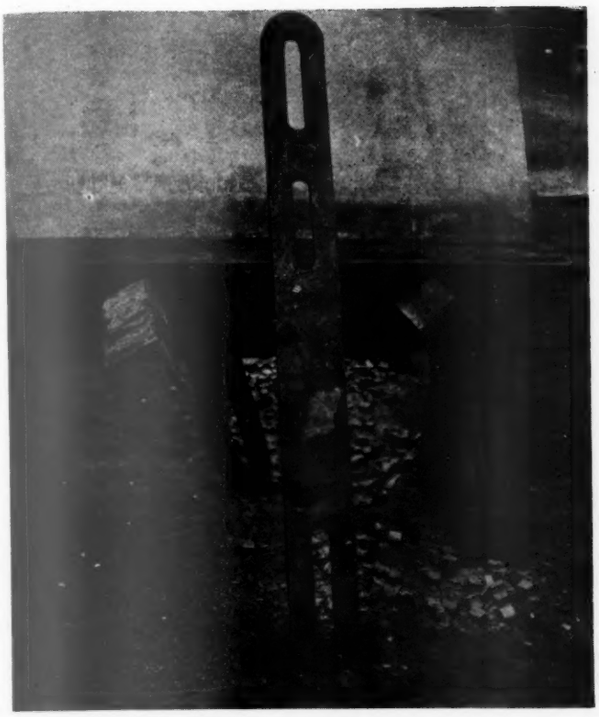
chassis. On this floor, in the central portion, is a boxed-up section with sides 6 in. high, in which triple valves, air hose, angle cocks, retaining valves and a single-car tester can be carried. At each corner of this box is bolted a 12-in. iron strip which extends upward. In the middle of the outer edges of each side and end of the platform a piece of iron is also bent and bolted to the floor, extending 12 in. upward. These eight pieces serve as a rack on which to coil the air hose. Small stencils, squirt cans, wrenches, white lead and a brush for applying stencils are carried in a small box at the rear of the platform outside the coil of hose. This box is next to the handles of the wheelbarrow and can be bolted down, or be loosed so it can be removed and carried under the car. Under the platform and between the blocking which supports the end of the platform extending over the wheel, a shelf or pocket is built to provide a space for large size stencils.

A can of brake-cylinder lubricant and a brush to apply it are hung from the right hand side at the front, while on the left side at the front is hung a bucket of soapy water and a brush for testing for leaks. Packing cups, gaskets and a can of black paint for obliterating the old stenciling are slipped over the handles. A 2-in. by 4-in. board is bolted to the legs of the wheelbarrow. This projects about 8 in. outside of each leg to give the wheelbarrow a more secure footing and to prevent it from turning over on uneven ground.

Reclaiming Draft Links on the B. & O.

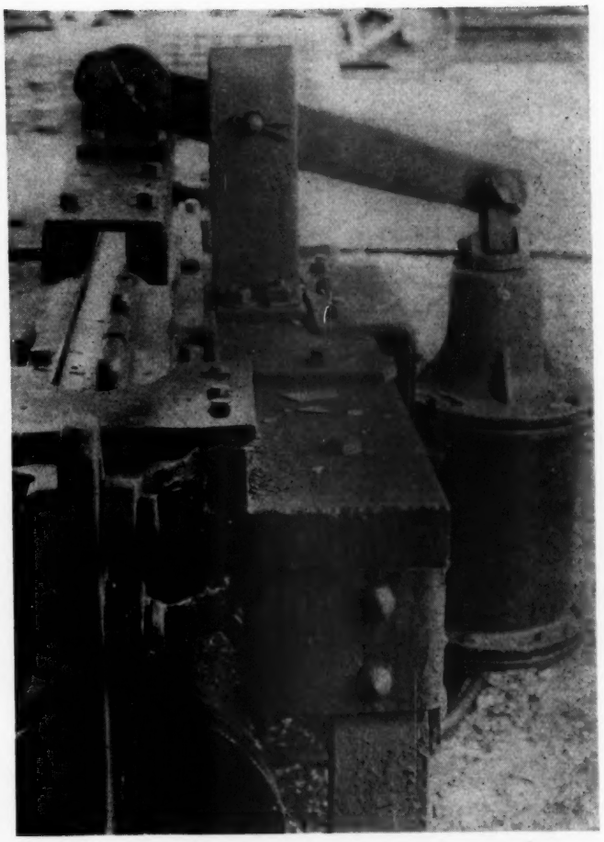
WHEN the links that are used with the Farlow draft gear become worn in the ends of the slots restore them to the original dimensions or scrap them. At the Lorain, Ohio, car shops of the Baltimore & Ohio will be found a reclaiming machine developed for this work which does an excellent job and does it rapidly. The machine is an air-operated upsetting machine having dies which conform to the original dimensions of the draft link. The five illustrations show the equipment that is used to perform the work and the successive stages of the operations.

In the link illustrated the wear in the end of the slot amounts to from ½ to ¾ in. Before any of the machine operations are made the links are placed in an adjacent furnace, heated to about 1,200 to 1,500 deg. F. and are then placed in the machine so that the die locators are inserted in the key slots in the link. The channel-shaped clamp on the vertical ram of the machine comes down and holds the link firmly against the die and prevents buckling when the end rams upset the metal in the link. There are three air cylinders on the machine, two which operate the end rams and one for the vertical ram. The end rams serve to upset and shorten the heated link so that the metal is squeezed around the slot formers in the die. Two kick-off pins, one at either end

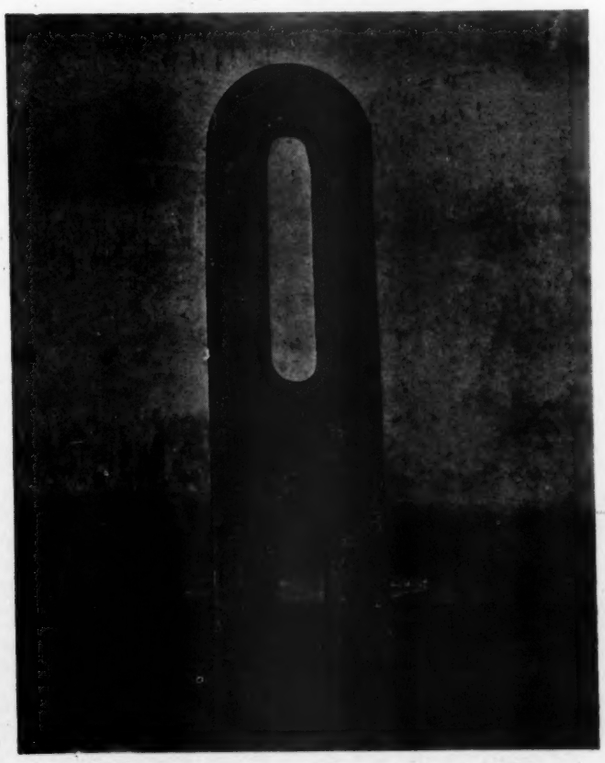


One of the draft links as removed from a car

When the air is applied the clamp holds the heated link in place while the ends are upset



The reclaiming machine has a die with locators for the slots in the links



A view showing the wear in the end of the slot

of the die, release the link from the die when the upsetting operation is completed and the clamp is released by the operating valve.

After heating, the links are placed in the machine—This view was taken before the clamp was lowered

If there is any distortion of the links as a result of the upsetting operation they are placed on a face plate and straightened out with a few blows of a light sledge.

Decisions of Arbitration Cases

(The Arbitration Committee of the A.R.A. Mechanical Division is called upon to render decisions on a large number of questions and controversies which are submitted from time to time. As these matters are of interest not only to railroad officers but also to car inspectors and others, the Railway Mechanical Engineer will print abstracts of decisions as rendered.)

Responsibility for Cars Damaged in Switching

Missouri Pacific box car 37265 of wooden construction but equipped with metal draft arms extending 24 in. beyond the body bolster, failed while being switched by the Kansas City Terminal Railway at a speed of approximately five to ten miles per hour. The car was one of a cut consisting of eight loads and four empties which was switched against 12 other cars standing at rest. The cars were not damaged, derailed or sideswiped and not subject to any of the provisions of Rule 32. The extent of damage to the car was as follows: four wooden intermediate sills broken; two wooden side sills broken; one wooden end sill broken; one end plate broken; two draft sills broken at splice; one side plate broken; two end posts broken; two cross ties broken; decking boards broken; side and end siding broken; and truss rods bent. The handling line contended that the car was being handled in the regular manner and routine of switching and that the cars were furnished with rider protection and every precaution was taken to insure safe movement of the cars. The Missouri Pacific maintained that the handling line was responsible according to Interpretation No. 11, Rule 32 and Arbitration Decision 1505, inasmuch as the car was second from the head end of the moving cut. The owner further contended that Decision 1505 applied to all cars regardless of construction, whether all-steel, steel underframe, or steel center sills.

The decision rendered the Arbitration Committee was as follows: "The damaged car was the second one in moving cut. The rider failed to control the speed sufficiently to prevent the combination damage. There is no evidence that the failure of five or more of the eight damaged longitudinal sills was due to old defects such as noted in Section (1) of Rule 44. Handling line, therefore, is responsible, in accordance with Decision No. 1505 and Interpretation No. 11 under present Rule 32."—*Case No. 1634—Kansas City Terminal Railway vs. Missouri Pacific.*

Wheels and Axles Removed Within 60 Days Account of Wear

On March 20, 1928, Fairport, Painesville & Eastern car 278 was set out on the New York, Chicago & St. Louis on account of a cut journal. The journal was trued in a truing machine and the wheels were replaced under the same car.

On May 4, 1928, these same wheels were removed by the Baltimore & Ohio on account of one wheel having a vertical flange. The owner claimed that the wheels failed to give the service required in Interpretation 10 of Rule 98 and contended that the repairing line did not use the remounting gage as set forth in A.R.A. Rule 82, since the wheels were removed 45 days after the axle was trued on account of a worn condition. The N. Y., C. & St. L. maintain that the wheels were gaged with a wheel and coupler gage and also with the remount gage and were found to be serviceable. It stated that there was no charge involved against the car owner and as the wheels were in good condition, Interpretation 10 of Rule 98 should not apply. The repairing line maintained that the car owner received full service from its own wheels.

In rendering a decision the Arbitration Committee stated "Interpretation No. 10 of Rule 98 is intended to cover wheels which are applied to a foreign car from the stock of the repairing line and does not apply to the case in question. Therefore, the contention of the New York, Chicago & St. Louis Railroad is sustained."—*Case 1637—Fairport, Painesville & Eastern vs. New York, Chicago & St. Louis.*

Personal Contact With the Car Inspector

Keeping the car inspector posted on changes in the A. R. A. Rules, Arbitration Cases, etc.

By A Car Foreman

NO more important duty is required of the general car foreman than that of keeping in close personal contact with his car inspectors, air brake inspectors and foremen in order that he may know, beyond doubt that they are familiar with changes in instructions, the A. R. A. Rules of Interchange and Loading Rules and rulings made by the Arbitration Committee from time to time. Various ways of accomplishing this are being practiced, some by personal visits to the individual interchanges, yards and shops, by scheduled monthly or semi-monthly meetings or by mailing out questionnaires each month and having them returned after being studied and answered by the men. While it is reasonable to assume that the general car foreman does make the rounds of his shops and yards periodically, if his jurisdiction extends over a large territory it is impossible to cover it as frequently as is desirable to afford close personal contact. Visits with car inspectors at individual yards is essential in order to determine that proper safety precautions are being taken in the performance of their duties, that trains are being stretched by the incoming train crews to afford better means of determining draft gear conditions, that material necessary for light-repair work is available, etc. However, it is not always possible to go over the rules and other important instructions while the men are on duty, or to spend sufficient time with them to answer their questions.

To the General Foremen

How do you keep your car inspectors and foremen in touch with the changes and interpretations of the A. R. A. Rule? Do you depend upon their initiative or do you employ means to assure yourself that they are familiar with such changes? How do you maintain their interest? Are you receiving their full co-operation in this matter? Herein are described various means of accomplishing these ends. Some means of determining the inspector's fitness for his position as regards familiarity with the A. R. A. Rules is necessary if you are to receive the utmost protection for your road at interchange points.

Questionnaires

In order to determine the car inspector's fitness for his position as regards familiarity with the A. R. A. Rules of Interchange, a questionnaire is being sent out to each car foreman, assistant foreman and car inspector on the first of each month by one large railroad. This questionnaire contains 10 questions, the answers to which can be found in the A. R. A. rule book. The individual to whom it is forwarded must look up the answers and return it to the general car foreman within 15 days of its receipt, filled out properly. If he fails to answer 60 per cent of the questions correctly, the questionnaire is returned for correction. Usually the grading of these questionnaires rate over 90 per cent, as the car inspector has very little difficulty in finding the correct answers in his rule book and once he writes them down there is small likelihood that he will soon forget them. Ten questions which were selected at random from the A. R. A. rules by a general car foreman and mailed out recently are as follows:

1—Is the application of bolts in place of rivets considered wrong repairs in all cases?

2—When removing and replacing carrier-iron bolts over six inches in length account of change of coupler, why should repair cards show it horizontal or vertical carrier-iron bolts were removed, replaced or renewed?

3—If cars are equipped with a metal badge plate showing the dimensions of brake levers, when should the levers be checked to assure their conformity with the dimensions shown on the badge plate?

4—If the vertical thickness of the top portion of the eye on a brake-beam head supported from the top hanger eye is worn to 7/16 in. or less, should the beam be removed and considered as scrap?

5—If new cast-iron, cast-steel or one-wear wrought-steel wheels are applied to an axle with wheel seat ⅛ in. or less in excess of maximum standard diameter, can a charge be made for new wheels?

6—If wheels are changed under system cars on the line of road on account of being loose, out of gage or having oil seepage and there are indications that wheels have recently been applied on a foreign line, should joint evidence be prepared?

7—What is the limit of time that a car owner is protected for wheels found out of gage, loose or having oil seepage?

8—If a box-car side door is in such condition (owners defect) as to warrant the application of a new door, why should the repair card show what material would be necessary to repair the old door (same as if repaired) in addition to showing the new door applied?

9—When cleaning a passenger-car triple valve or control valve, what other parts must be cleaned to justify a charge being made against the car owners?

10—If a brake cylinder gasket is defective and the stenciling on the car shows that the air brakes have been cleaned within nine months, should the air brakes be cleaned according to Rule 60?

It can readily be understood that, by diligently following up the questionnaire method and observing those

inspectors and foremen who do not rate high in their examinations, much good can be accomplished. However, this system still lacks the personal appeal and even though some of the questions published are submitted by the car inspectors, there are numerous queries with which the inspectors are daily coming in contact and with which they should become familiar.

Car Inspectors' Meetings

What better means has a general car foreman of getting in close personal touch with his inspectors than by holding scheduled meetings—meetings where all car inspectors, both freight and passenger car, gather for the express purpose of discussing the changes in the A. R. A. rules of interchange, the loading rules, arbitration decisions, or new instructions which are issued from time to time? Such meetings are being held once each month by an eastern railroad and are being attended by car inspectors, air-brake inspectors and repairmen, car repairmen and others whose duties require a knowledge of the interchange rules as respects train handling. These meetings were started about two years ago and created considerable interest among the car inspectors. Group meetings are held by car inspectors employed within divisional territories, a chairman being elected by regular ballot by the inspectors themselves. The chairman serves during a period of from three to six months. The general car foreman, while not taking an active part in the conduct of the meetings, is present at each meeting for the purpose of deciding questions which may arise and so that he may take up for correction or advice all matters brought out during the course of the meeting which cannot be satisfactorily passed on immediately because other departmental responsibilities are involved.

Air-brake instructors are invited to attend these meeting every three months, at which time short lectures are given on the handling of air-brake equipment and any questions which might arise pertaining to air-brake handling with which the car inspectors or air-brake men are not familiar are settled. Not infrequently the divisional officers, including the superintendents, trainmasters and others are invited to attend and their attention is called to matters which are in need of correction. The presence of these officers, instead of lessening the ardor of the men, tends to increase their enthusiasm.

While it is impossible for all car inspectors to attend these meetings regularly due to assignments on the night shifts, it is found that so great is their interest in attending that they frequently trade off jobs with each other to afford the inspectors working on night shifts an opportunity to attend at least one meeting each three months. This is not sponsored by the railroad company. although their action is welcomed in the interest of better education.

A stenographic record is kept of all discussions and the minutes of the meeting are published in mimeograph form and sent out to all car inspectors, car repairmen, air-brake inspectors, air-brake repairmen and others in attendance. Copies are also forwarded to those who were unable to attend in order that they may derive the benefit of the discussions and retain their copies for future reference.

Subjects Discussed

At a recent meeting, the question of having the monthly questionnaire prepared and sent out to all inspectors, similar to the set of 10 questions mentioned previously in this article was discussed. It was the consensus of opinion that monthly meetings were more beneficial and enlightening, as it was possible to get the benefit of the numerous discussions, looking at the matter from several sides and that, when decisions were made, all inspectors would have the same interpretation. It was agreed however that where car inspectors' meetings were not an established practice the questionnaires were instrumental in keeping the car inspector and foreman posted and acquainted with the rules.

The following quotations are made from the minutes of one meeting.

"Inspectors located at interchange points must remove defect cards from cars being returned home in damaged condition and check the defects against the car to assure that defect cards cover all damage. It is sometimes difficult to secure additional defect cards after a car has arrived at the home shop, also the A. R. A. rules provide that car inspectors located at interchange points relieve the delivering road of all responsibility after a car is accepted.

"Brake beams worn below the prescribed limits shown in the A. R. A. rules should not be applied to foreign or private line cars. Several cases were called to our attention where brake beams with heads worn were removed a few days later by the road applying, and the car owners would have received duplicate bills except for the alertness of the billing bureau.

"Defect cards should not be issued for minor defects (old) which do not interfere with the movement of the car unless the damage occurred under the provisions of Rule 32. Such being the case, defect cards should be issued and attached to the car immediately to prevent delay to the car at interchange and where the car inspector is not familiar with the facts as to how the damage occurred.

"In accordance with the provisions of Rule 4 a defect card should not be issued for siding raked unless it is raked through the tongue and groove.

"Several cases of system hopper cars arriving on repair tracks with cast-iron wheels applied in place of wrought-steel wheels, notwithstanding that the stenciling on the car indicated that wrought-steel wheels were standard, were traced and found to have been accepted from foreign lines at interchange and no defect card obtained by the inspector located at the interchange point.

"In selecting cars for re-light-weighing, the month stenciled on the car is counted as a month in computing the date at which the car is due for re-weighing. Cars must not be weighed during rainy or snowy weather as actual weights cannot then be obtained.

"An interpretation of Rule 2, with regard to refusal of cars at interchange containing refuse was read as follows: Rule 2 applies only to the mechanical and physical condition of cars and cannot be considered as covering cases involving the cleaning of equipment. Arbitration Case No. 170, Car Service Rule 16, must be considered as a recommendatory rule only, and bills can only be rendered for removing of refuse or rubbish through mutual agreement on a reciprocal basis.

"Rule 36 forbids interchange of cars having advertisements attached to temporary braces or standards which are being placed in the cars for the sole purpose of display. Advertisements secured to bracing which has been applied to secure the lading in the car is not prohibited.

"Wrong repairs which are corrected on foreign cars on authority of a defect card cannot be billed against the car owner, neither is the company which corrects the wrong repairs, unless it is the owner of the car, permitted to render a bill against the company issuing the defect card.

(Concluded on page 468)

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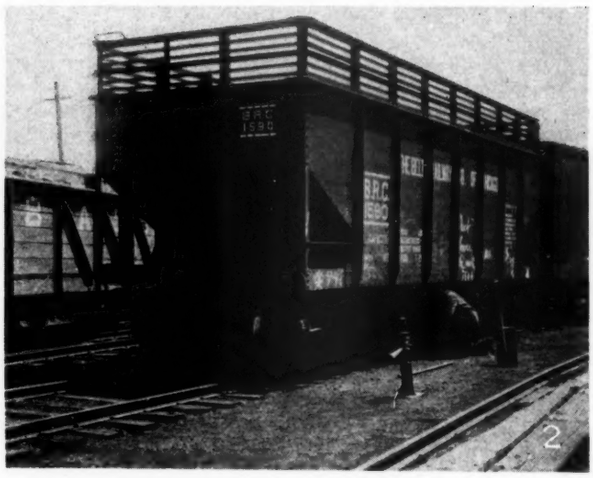

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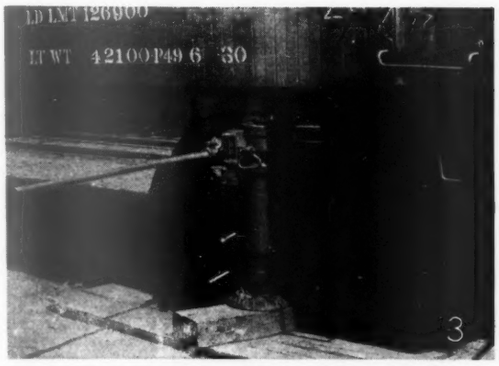

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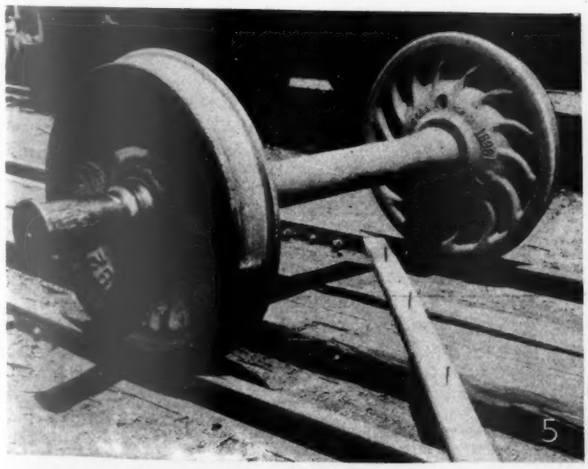
"Don'ts" for Car Men

THE "don'ts," illustrated, are all well known to the average car shop foreman and inspector and yet cannot in all probability be emphasized too often in the interests of safety in the car department.

Carelessness in tightening and loosening nuts on various parts of the car structure is no doubt responsible for many accidents and resultant loss of man-hours of service. An experienced and careful car-repair man can almost always be identified by the way in which he applies a wrench to a nut and starts either to tighten or take it off. With due attention to a firm footing and working with a wrench in proper condition, he applies the wrench to the nut in such a way that he can pull to the best advantage without the possibility of "skinning" his knuckles. Moreover, he takes ample precaution against losing his balance and falling, or bumping against any tools or material piled adjacent to the car, in case the nut suddenly "gives" or the bolt twists off. The nut-tightening operation shown at (1) may not always be particularly dangerous but, in general, it is undesirable to work from side or end ladders when well-built hand ladders or scaffolds, provided in most car repair yards, can be used with greater safety.

The danger of working around or underneath cars unprovided with blue flag protection is generally known, but, in spite of the best efforts, the rule is frequently



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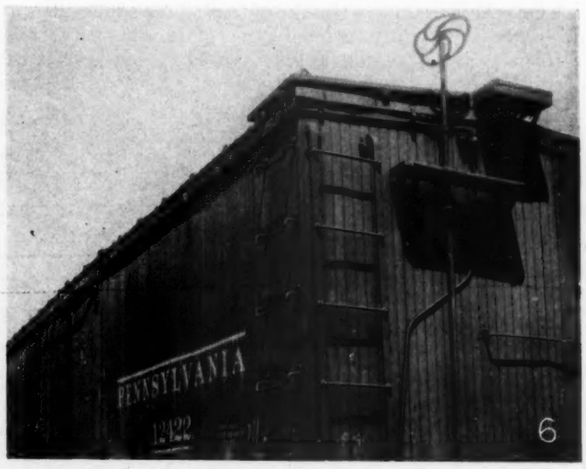

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violated. A typical example of how this may be done is illustrated at (2).

Efficient modern jacks are a great aid to car-repair work and when properly used not only effect a substantial saving in labor but are entirely satisfactory from a safety viewpoint. Certain precautions in the use of these jacks must be observed, however, and one of the most important of these, illustrated at (3), is not to leave the operating handle in the jack at any time except when being used to raise or lower a car. A handle left in a jack, as illustrated, not only provides an obstruction to movement about the car, but, should the releasing mechanism fail or possibly be tampered with, there is a good prospect of the handle flying up and possibly hitting a man or pinning him against the car.

Most car men appreciate the danger of going under a car supported only by jacks, as illustrated at (4). In case only a minor job involving but two or three minutes' work under the car is required, however, there is quite a temptation to go under the car and do this work without taking the trouble to locate suitable horses, possibly bring them from a distance and install them properly under the car frame, in the interests of safety.

Nails projecting from lumber which is allowed to accumulate and lie around always present a potentially dangerous condition. Never-ending caution is essential in this particular, and, in spite of the greatest care, nails are occasionally found waiting for the unsuspecting foot of the car-repair man, as illustrated at (5). The answer is, of course, for the car shop or rip track supervisor to impress upon each one of his men the necessity of hammering over the offending nail whenever he sees one or removing the lumber containing the nail to a safe place.

Car men who remove the cotter and nut from the top of a brake shaft without at the same time taking off the hand wheel contribute to a dangerous condition which has frequently resulted in accident. Workmen underneath may not appreciate that the hand wheel is insecurely fastened and a sudden blow or jar on the lower end of the brake shaft is quite likely to dislodge the hand wheel, permitting it to fall directly on them.

An Axle Storage Rack

ONE of a pair of horses which forms a rack designed for the storage of axles at an axle lathe or at a car-wheel press is shown in the drawing. It is made of an inverted section of 60-lb. rail supported by three sets of legs bolted to the web of the rail. The legs at one end of the rack run to a height of 4¾ in. above the rail to form a stop for the axles. Sections of flanges of the rail are burned out to permit this extension of the end legs.

The rack is 7 ft. in length and stands 18 in. high. The legs, of 1-in. by 3-in. iron, are bolted to the web of the inverted rail by ¾-in. bolts and are fitted with ½-in. by 1½-in. braces located 2¾ in. above the floor. The braces are secured to the legs by means of ⅝-in. bolts.

Car Inspector Contacts

(Continued from page 466)

"In the case of couplers lost out on the line and cars which do not bear stenciling indicating the kind of coupler which is standard, the inspectors must show the kind of coupler in the other end. Car owners can be billed for labor and material when couplers, including yokes, springs and followers (any or all) are lost with the coupler provided draft gear is still intact.

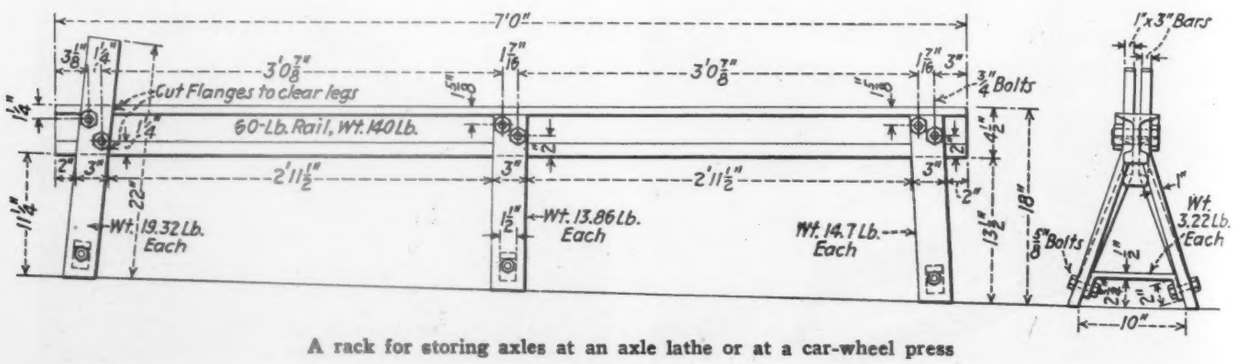
"An interpretation of paragraph (d), Car Service Rule 14 was made. This rule reads 'When cars cannot pass the approved clearances of the American Railway Association,' which is made clear in Rule 2, which reads 'When cars cannot pass the approved third rail clearances etc.' In the case of high cars, offered in interchange which cannot pass the clearances, other than third rail clearances, cars must be accepted by the receiving road and transferred at their own expense.

"Wide cars and lading must be measured from the center line of the car to the widest point, and this measurement multiplied by two to determine the width. Special attention must be given to door tracks or hoods which extend out at the eaves."

Conclusion

While the above does not cover all of the discussions which took place at this meeting, it will indicate the many important subjects which are being reviewed, and which the car inspectors become thoroughly familiar with, all of which serves to develop the car-inspection forces to a higher degree of efficiency. The meeting was attended by 53 employees engaged in the inspection and preparation of trains in the train yards, together with foremen and work checkers on the light-repair tracks.

In climates where the months of June, July and August are extremely warm, meetings are not held, as it is found that the attendance is usually small. Questionnaires were adopted to keep the interest stimulated and, together with more frequent visits to the train yards and interchange points by the general car foreman, they have resulted in maintaining the interest and co-operation of the men.



A rack for storing axles at an axle lathe or at a car-wheel press

In the

Back Shop and Enginehouse

Frisco Wheel and Box Work

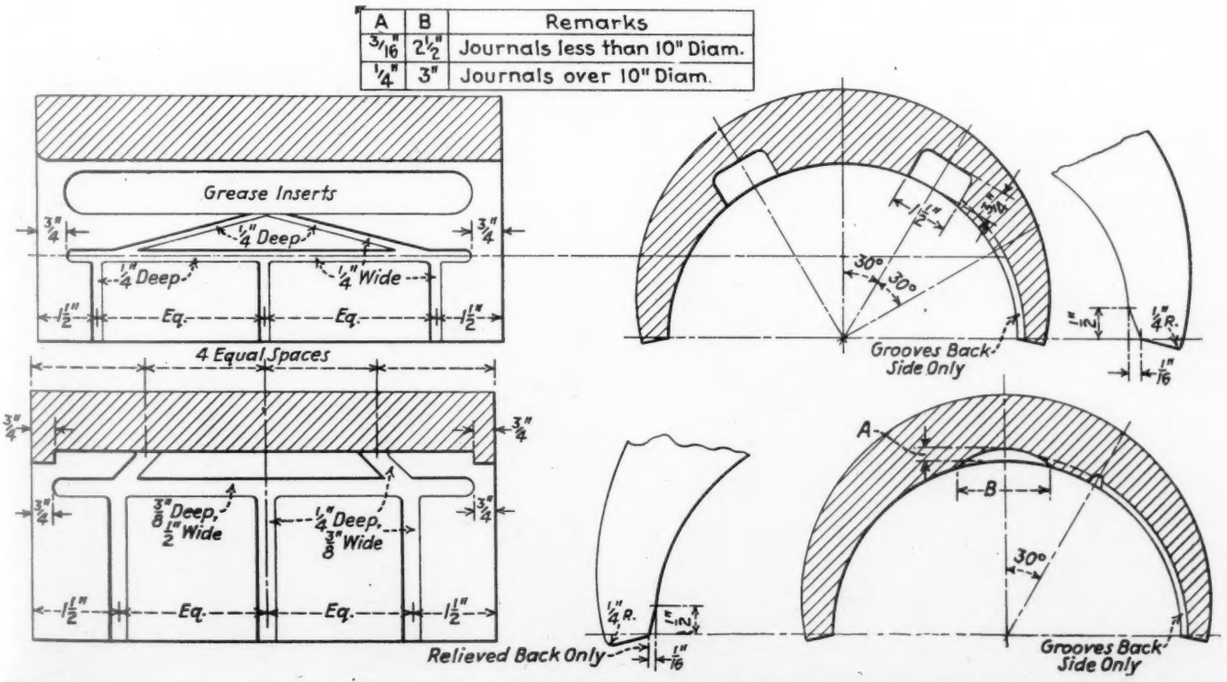
THE most exacting care is used in driving-wheel and box work at the main shops of the St. Louis-San Francisco, Springfield, Mo., to assure accuracy, in the interests of reduced wear of moving parts, elimination of flange cutting and more generally satisfactory locomotive performance. Ordinary care was always exercised in this work at the Springfield shops but a thorough analysis of the work indicated the need of much closer attention to details. Every step in the work was carefully studied and several special gages and tools designed to make work of high accuracy a practicable possibility.

The character of wheel and box work done on locomotives turned out of the shops is shown by the fact that, with all the lateral play on one side, a line stretched along the centers of the driving-wheel flanges on either side of a locomotive will show a minimum variation of 1/32 in., except for the front and back pairs of 4- and 5-coupled drivers, the tires of which are intentionally set $\frac{3}{16}$ in. closer together. Another proof of the accurate alinement and careful fitting of driving boxes was afforded recently when a heavy modern locomotive, just placed on the driving wheels, was pushed entirely by hand power from the erecting shop to the transfer table and back again to the erecting shop, using about 30 men. With proportionately careful work in other details, Frisco locomotives are now broken in ready for fast passenger service after about 300 miles, whereas formerly they were so stiff that the switcher could move them only with difficulty, and two to three week's operation in slow speed service was necessary before they were thoroughly limbered up.

Method of Operation—Wheels

All locomotives given Class 1, 2 and 3 repairs at Springfield shops are thoroughly cleaned by sandblasting. The locomotives are unwheeled, binders being sent to the annealing furnace where the remainder of the grease is burned off and the binders thoroughly annealed. Driving boxes are stripped, annealed and sent to the box department. Clean grease is reclaimed from the driving box cellars, which also go to the box department. Driving wheels are handled by the crane to the wheel job, where they are carefully inspected for cracks and the tires removed if they will not turn down to the shop limit of wear. All crank pins are removed, the holes being checked to make sure that they are in quarter, and new crank pins, finished by grinding, are applied. The journals of all new axles also are ground. The wheels are carefully counterbalanced, enough weight being removed or applied to balance the thrust on each pair of wheels. In other words, excess weight is not applied in one pair of wheels to offset the deficiency in some other pair.

The foundation of any locomotive is a pair of rigid, straight frames, with square pedestal jaws. Frisco locomotives receiving heavy repairs are string-lined from the cylinder centers to the rear of the frames. These lines are set parallel with the frames and a check made at each jaw, any bowing of the frame being thus detected and the necessary allowance on driving box lateral brasses made. Worn binder jaws are built up



Method of grooving and relieving main brasses (below)—All other brasses (above)—This applies to passenger power only

by electric welding, slotted and fitted to the pedestals with ¼ in. to $\frac{3}{16}$ in. draw. The main frame centers are established in the usual manner, being stepped forward and back the proper amount to locate the shoe and wedge points. Standard rod trams are used to transfer these marks to the other frame jaws and shoes and wedges.

The next operation in connection with the driving wheels is to check the rims, in case of tire removal, with a straight edge, as shown at *A* in one of the drawings. The gage is marked on two sides, one of which is used for front or back wheels and the other for intermediate and main wheels. The dimensions *Y* must be the same on both wheels and distance between the retired rims *Z* must be exactly to gage. Different thicknesses of wire from $\frac{1}{16}$ in. to ¼ in. are available for

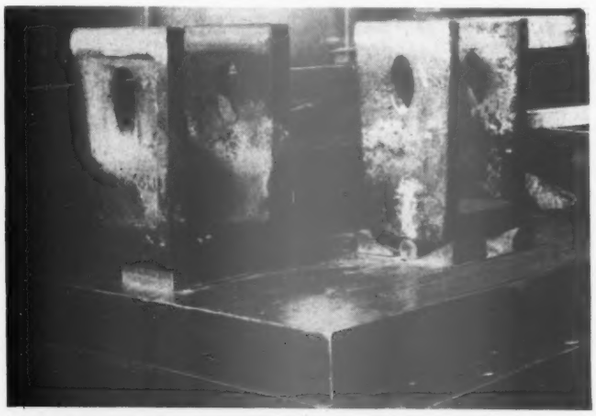


Plate on which spring saddles are checked for squareness and correct height

application by electric welding to build up the rims so that they can be turned in the wheel lathe and made to check with the blueprint size. The tire lip must fit snugly against the outside of the rim all the way around the circumference except in the case of old tires bored deeper than 4⅝ in. from the center line of the flange, in which case the rim thickness is built up the required amount in four equally spaced spots about one inch long, this material being subsequently removed on the application of new tires.

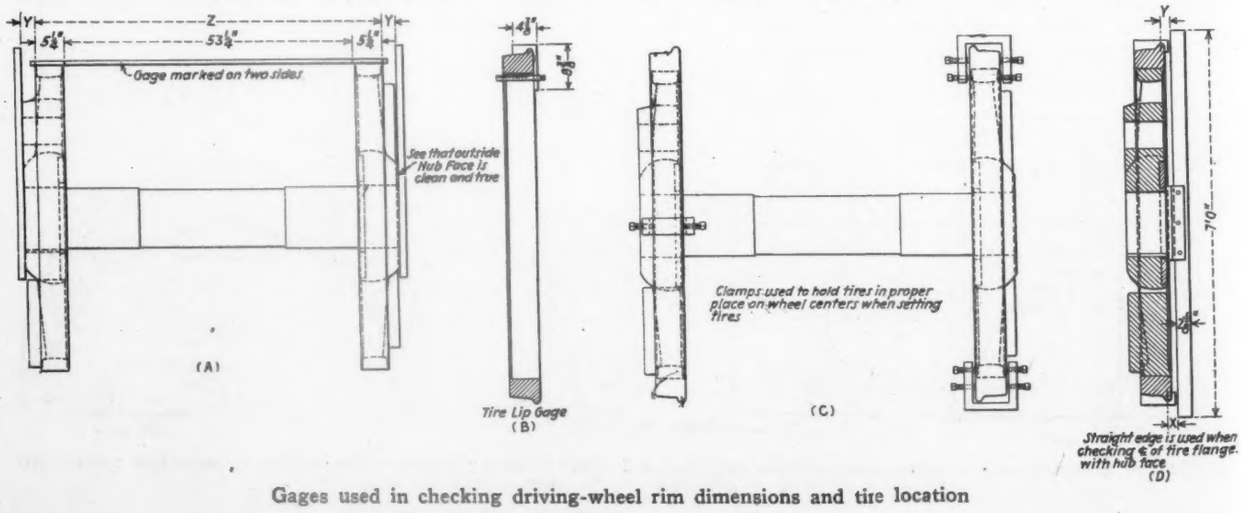
Tires are bored standard, using the lip gage illustrated at *B*. This gage is simply placed on the contour of the tire, the scale on the gage indicating accurately the distance from the center line of the flange to the lip, which should be 4⅝ in. The tires are then shrunk on the wheel centers, the lip tight against the wheel-center rim, with every assurance that the tires will be true. Clamps, used to hold the tires in the proper place up against the rim when setting, are shown at *C* in the drawing.

A light cut is taken over new tires, after application, to make sure that they are exactly concentric and true. All journals, not renewed and ground, are turned and rolled. Hub faces are checked, using the straight edge and special gage shown at *D* in the drawing. The offset edge of the straight edge is placed against the hub face and the distance *X* measured from the straight edge to the center line of the flange. This distance must be the same all around the tire and also the same on both wheels on the same axle, thus assuring equal hub thickness. It is not necessary for the dimension *X* to be the same on more than one pair of drivers. When necessary, new cast-iron hub plates are applied, being held by ¾-in. copper plugs for small locomotives and ⅞-in. plugs for large locomotives. Thirteen of these plugs, equally spaced, are applied with a drive fit in holes 1½ in. deep, in the hub and upset in the countersunk holes in the hub plates. The hub plates are clamped firmly in place during the upsetting operation. The hub plates are faced off to give equal hub thicknesses and the proper spacing. In no case is this operation done before application of the tires.

How the Boxes are Handled

After being annealed and returned to the driving-box department, all boxes are carefully inspected for cracks and defects. The lateral brass is cut off on the boring mill and worn steel liners in the shoe and wedge ways cut off with the oxy-acetylene torch. All boxes are calipered and, if one inch undersize across the shoe and wedge faces, new ⅝-in. steel-plate liners are applied. These liners are held by electric spotwelding at three points, and by electric welding along the top and bottom. Six spots are found to be adequate on the large wide-faced boxes. The boxes are then planed and reslotted, if necessary, to give the proper lip bearing against the crown brass.

New crown brasses, turned in a jig on a Bullard 34-in. vertical turret lathe and slotted for the driving-box fit, are then applied, each brass being held in the box by two 1¼-in. brass plugs, driven in from the journal



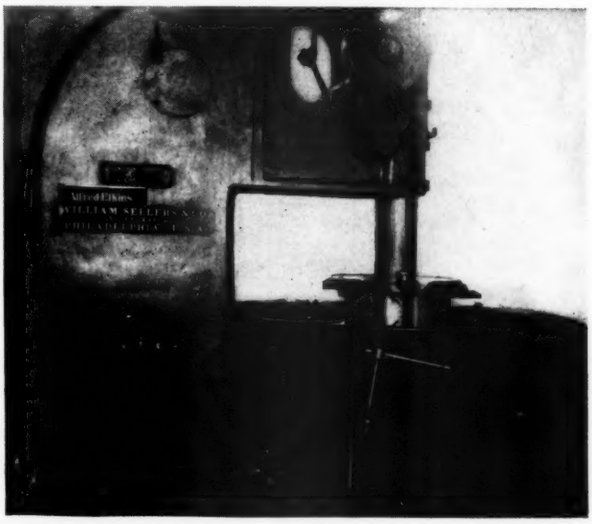
Gages used in checking driving-wheel rim dimensions and tire location

side with a taper of $\frac{1}{16}$ in. in 12 in., and riveted over on the top. Steel plugs, $\frac{5}{8}$ in. in diameter and about 2 in. in original length, are driven into suitable holes in the side of the box, and expanded on the ends to hold the lateral brass, which is then poured. Plugs, applied by this method, have been found to hold just as well as if threaded into the box and, in conjunction with the double V-ways turned in the side of the box, give sufficient holding power to keep the lateral brass firmly in place. Each box is then checked with a special gage to see if the bore is central with the shoe and wedge ways. If not, the necessary correction is made when the boxes are planned to blueprint. Oil grooves are chipped in the shoe and wedge ways, which are then filed smooth.

The boxes are put on the special Sellers 54-in. boring mill, illustrated, and rough bored and faced. This mill is equipped with a universal chuck and double table with adjustment feature. A Davis boring tool with convenient micrometer adjustment assists in the rapid and accurate boring of the crown brasses. The effective chip guard illustrated deflects all chips downward to a point where they can be readily collected for removal to the scrap dock. A hinged door on the front of the chip guard gives ready access to the boring-mill table and facilitates handling driving boxes into and out of the machine. It will be observed that the operator's name is neatly lettered on a board and attached in a conspicuous place on the side of the machine. This is common practice at the Springfield shops and results in the men taking more personal interest in their machines, keeping them clean and in good working condition.

Method of Forming Grease Grooves

After rough boring and facing, the driving box is removed from the mill and oil grooves chipped in the crown brass, as shown in one of the drawings. It will be noted that main driving box brasses are relieved in the crown. Brasses other than main have two grease inserts on passenger locomotives only. These grease grooves are cored $1\frac{1}{4}$ in. wide and $\frac{7}{8}$ in. deep in the rough and milled out to $1\frac{1}{2}$ in. wide, all sand and dirt being carefully cleaned out of the bottom of each groove. The brasses are relieved on the back only, for a distance of $\frac{1}{2}$ in. up from the center line. The boxes are then put back on the boring mill and the finishing cut taken on the lateral brass and the crown brass. Special allowance is made for the fillet which is run down $\frac{3}{16}$ in. by 1 in. to make sure that the side bearing rather than the crown brass takes the thrust of the driving-wheel hub plate. The crown brass is then rolled .007 in. larger than the journal. Brasses other than main are bored and rolled 1/32 in. larger than the journal. The single plain-bearing roll, used in rolling the brasses, is shown in the boring mill illustration. With this method of finishing the brasses, a hard, smooth and accurate bearing is obtained on the journals without scraping. Each box is, however, tried on its journal with lamp black to make sure that it has a full bearing.



Sellers 54-in. driving-box boring mill equipped for rolling brasses

Convenient portable tripod and chain hoist used in applying driving boxes

Saddle-box pockets in the driving boxes are checked with a special gage and, when necessary, built up to standard by electric welding, and chipped. The operation of trying a driving box on its journal is illustrated in a view which also shows the convenient portable tripod and chain hoist arrangement for handling the boxes. The method of attaching the chains to the driving box (not shown in the illustration) consists simply of a clamp and set-screw arrangement which grips the top of each shoe and wedge way. The illustration also shows the convenient two-wheel truck used in moving driving boxes about the floor, and three gages, including (left to right) the straight edge, the inside tire gage and the special gage for checking saddle pockets.

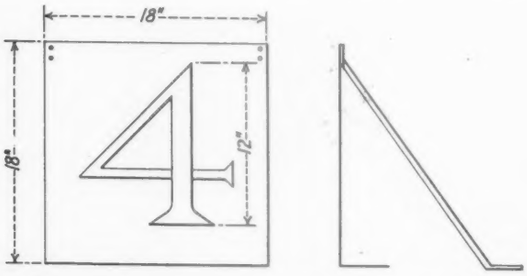
Particular attention is paid to the spring saddles, two of which are shown in an illustration. One of these has a recess milled to receive a flat spring band, whereas the other is milled for a pin bearing. The saddles are checked with a surface gage on the cast-iron face plates to make sure that the bearing surfaces are square with the center line of the saddle and of the correct height. Any machining necessary on the ends of the spring saddle is done on a slotter.

The driving-box cellars are also carefully fitted with end plates $\frac{1}{8}$ in. to $\frac{1}{4}$ in. from the journal, these cel-

lars being a light drive fit in the driving boxes. The cellars are bronze welded, if necessary, in making this fit. Driving-box grease grooves are filled with grease, the journals painted with a special lubricant, the boxes and packed cellars assembled, and the wheels are then ready for application under a locomotive.

Silhouette Stall Numbers

SILHOUETTE numbers which have been placed over enginehouse stalls at the Frisco shops at Chaffee, Mo., are shown in the drawing. The figures

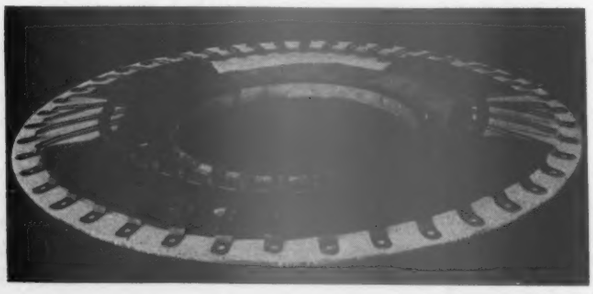


The numbers are cut out as stencils and set above the stall, silhouetting against the sky line

are 12 in. high and are cut out of jacket iron 18 in. by 18 in. for single digits, and 18 in. by 24 in. for double digits. They are fastened to the roof of the enginehouse over the center of each stall and are braced with $\frac{1}{16}$-in. by 1-in. strap iron. They stand out against the sky line and never have to be cleaned or painted, since the blacker they become, the greater is their silhouette effect.

Laying Out Boiler Front Stud Holes

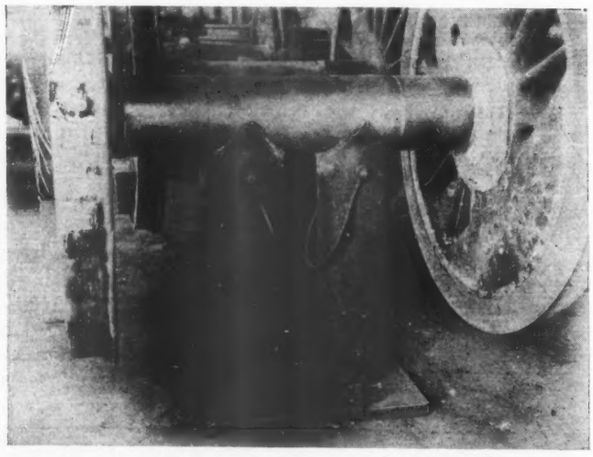
AN adjustable templet for laying out boiler-front stud holes is illustrated. This templet, while in use for a number of years, is probably not known to all readers of the *Railway Mechanical Engineer* and consequently may prove of some interest. The construction and use of the templet are readily apparent from the illustration. It consists of a ring provided with segments adjustable to each hole or stud in the boiler front ring. In use, the templet is applied to the boiler front ring in the reverse direction from that shown in the illustration and each segment adjusted to the hole or stud. By tightening the individual nuts, the segments are held in the proper position and the templet carefully moved to the machine shop where it is placed on the chalked boiler front, as shown in the illustration. The exact locations of the front ring holes or studs are then transferred to the boiler front and, on drilling no difficulty will be experienced in the application of the boiler front nor will it be necessary to chip any holes. In addition, the use of this templet saves the labor of moving the boiler front to the locomotive in the erecting shop and subsequently returning it to the machine shop for drilling.



Adjustable template which saves labor in accurately transferring stud hole positions from the boiler front ring to the boiler front

Portable Wheel Supports

A CONVENIENT device in the Denver, Colo., locomotive shops of the Chicago, Burlington & Quincy, for supporting locomotive wheel centers while tires are being removed, consists of two stands, made of 10-in.



This portable wheel support is of welded pipe

pipe welded on to a 16-in. by 30-in. base of 1½-in. plate. The top ends of the stands, which are 3 ft. high, are cut to a wedge shape and have a triangular section of ½-in. plate welded in to form an adequate support. A large clevis is bolted to each stand to facilitate its handling by a crane.

Device for Drilling Saddle Bolt Holes

A DEVICE for drilling cylinder saddle and other smoke-box holes, which is designed to eliminate the danger of drilling such holes crookedly and which decreases the time for drilling a complete set of these holes, is shown in the drawing. The device consists essentially of a three-legged front-end center, a split beam running from the center to the flue sheet and an adjustable feed screw which holds the drilling motor in place.

The brace center of the front-end centering device is

drilled 3-9/16 in. and made with three 3-in. bosses, 120 deg. apart, each of which is drilled and tapped to receive a 1¼-in. pipe. The three pieces of pipe forming the legs of the front-end centering device are 2 ft. 2 in. in length and in the end of each is placed an ordinary centering screw and nut for adjustment. The 1-⅛-in. centering screw is 24 in. in overall length, the hexagon portion being 1 in. long, the threaded portion 22¼ in. long, the pointed portion composing the remaining ¾ in.

The beam which runs from the centering device to the center of the flue sheet is 3½ in. in diameter, 9 ft. 6 in. long and, beginning 24 in. from the front end, it is slotted for a distance of 7 ft. 2 in. This slot is 1⅜ in. wide and runs to within 4 in. of the end of the pipe. The end of the pipe is fitted with a machined piece, one end of which is 2-9/16 in. in diameter to fit the pipe and the other end is 2 in. in diameter to fit a small flue.

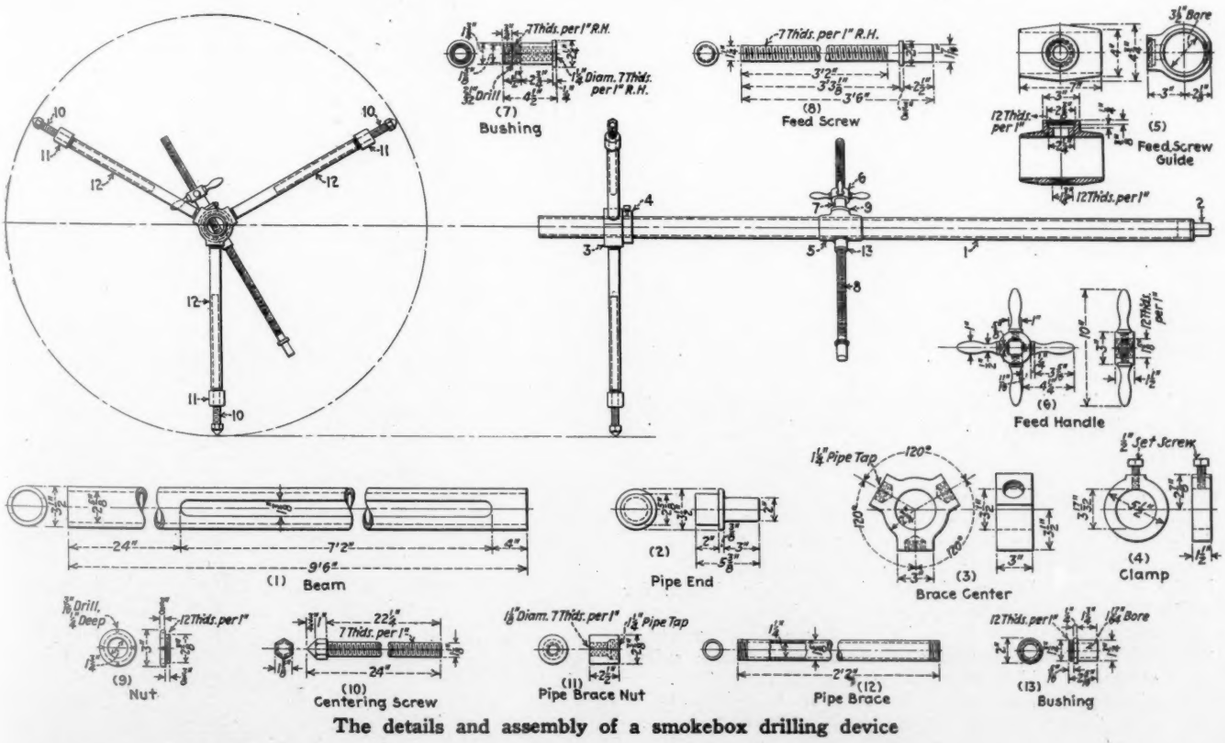
The adjustable feed screw, which is made up of a feed screw, feed handle, feed-screw guide and bushing, fits the slotted portion of the 3½-in. pipe beam. The feed-screw guide is 9 in. long, 4¾ in. outside diameter and bored 3½ in. The bushing which screws in the bottom of this guide and which aids in the alinement of the feed screw, is 2-5/16 in. long and bored 1-17/64 in. The bushing which is fitted into the top of the feed screw guide is 4½ in. long, threaded inside to accommodate the screw, and is fitted with a colar 2¼ in. in diameter on which rests the feed screw handle. This is fitted with four handles, the overall width of each pair being 10 in. The feed screw is 3 ft. 6 in. long, 3 ft. 2 in. of which is fitted with 1¼-in. R.H. threads and 2½ in. of which are machined to fit the drilling motor. This latter portion is machined to a diameter of 1-7/16 in. and a length of 2½ in. and is followed by a ⅜-in. collar 2 in. in diameter.

When in use the front-end centering device is centered just inside the front-end ring, after which the 9-ft. 6-in. pipe beam is run through the brace center to the middle of the front flue sheet. The adjustable feed screw is then mounted in the slotted portion of the beam. When the drill is set in the saddle bolt holes of the old smoke box, or in the center-punch marks of

Another device similar to that shown in the drawing which permits drilling at a point in a smokebox circumference without changing the set-up

new holes to be drilled, the adjustable feed screw is set in the motor, from which the small feed screw has been removed. This automatically insures alinement for the drill radially with respect to the smoke-box. The device thus relieves the mechanic of the necessity of alining the drill radially with the smoke-box and also eliminates the necessity of continually resetting an old man.

Another smoke-box drilling device similar to the one described in detail is shown in one of the illustrations. On the end of the horizontal pipe of this latter de-

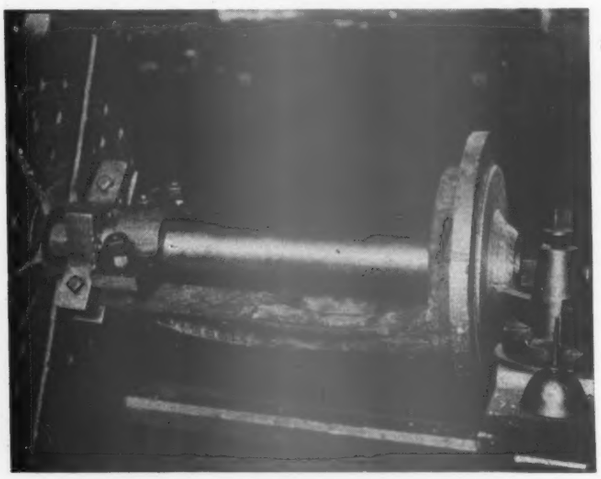


The details and assembly of a smokebox drilling device

vice is fitted a wooden plug which is slipped into the central boiler tube. Instead of the horizontal pipe being slotted, as is the case with the former device, the latter is fitted with a sliding and revolving collar on the pipe, to which the adjustable feed screw is attached. This device, as well as the former, permits drilling at any point in the smoke-box without changing the set up.

Machining Steam-Chest Heads

IN many shops it is the practice when machining steam-chest heads on which the guides are cast integral, to plane the guides first, then mount them on an angle plate with the head down, boring the stuffing box with a boring bar extending over the full length of the guides. This operation is then followed by the facing of the head inside and out. Any reader who has



A fixture designed to simplify the boring and turning of one-piece steam chest heads and guides

tackled this job has experienced the feeling one gets when the job shifts off center or the tools chatter because the set-up is not rigid.

The method illustrated was devised to overcome these objections and shows operations the reverse of those described above. The stuffing box is first bored by means of a horizontal boring bar, after which a mandrel is fitted and the head turned and bored out. It is possible to take substantial cuts due to the stiffness of the fixture. The casting is then clamped head down and the guides finished on a slotter, the large turned area of the head not only insuring greater rigidity but perfect alinement.

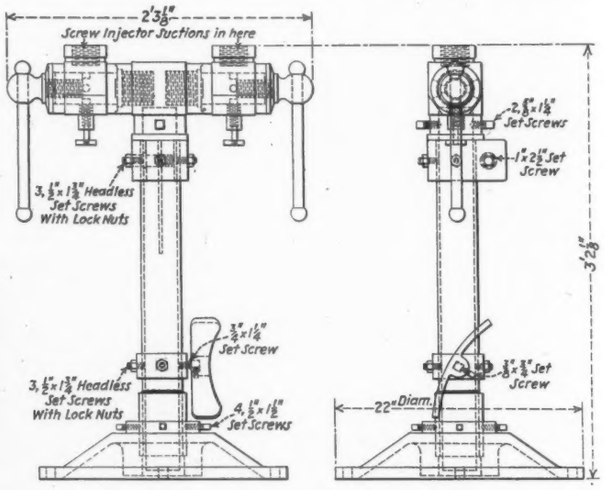
The method just described results in a considerable saving of time—the entire job can be completed in two hours.

A BELATED BUT DESERVED RECOGNITION has been awarded to vice-president Champ Carry, of the Pullman Car & Manufacturing Corporation, in the form of a Distinguished Service Cross. During the World War, Mr. Carry was a lieutenant in the 18th Field Artillery, Third Division. The citation for which the decoration was given, reads as follows:

"Lieutenant Carry, assisted by another officer, carried a wounded man under fire to a place of comparative safety, from where the soldier was evacuated to the rear. The utter disregard for his own safety displayed by Lieutenant Carry was an inspiration to the entire command."

An Injector Repair Stand

A STAND upon which injectors are mounted while undergoing repairs, and one which has been adopted as standard equipment in the shops of an eastern railroad, is shown in the drawing. It consists of two specially designed vise heads which are mounted on a vertically adjustable stand set upon a base 22 in. in diameter. The total height of the stand is 3 ft. 2⅛ in.



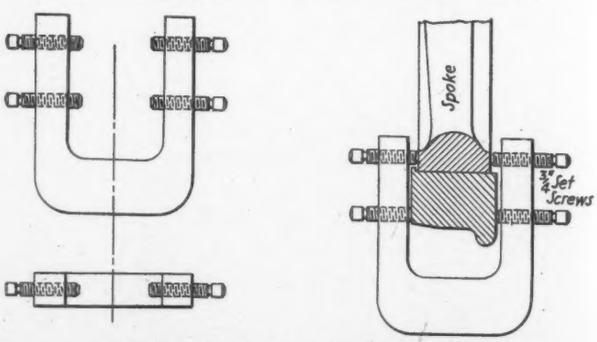
The injector is mounted on the adjustable stand while it is being repaired

and the overall width of the vise heads is 2 ft. 3⅛ in.

When in use the injector is screwed on the stand by means of the suction feed-pipe threads, the vise head being threaded for this purpose. When placed in the vise, the injectors can be set at any desired angle to facilitate repairs.

Adjusting Tires tn Correct Gage

SETTING tires straight and in gage is easily accomplished by the use of the special U-clamp shown in the drawing. Two set screws of the clamp tighten on the wheel center and the other two on the tire, by means of which the hot tire may be shifted to correct gage and then securely held. It is necessary to use a set of three clamps equally spaced around the circumference of the wheel to set one tire and is advisable to set the top of the tire in gage first. The four-screw clamps are satisfactory for general use as well as for setting tires and are steadier and grip harder than ordinary U-clamps.



A four-bolt U-clamp for setting tires

NEW DEVICES

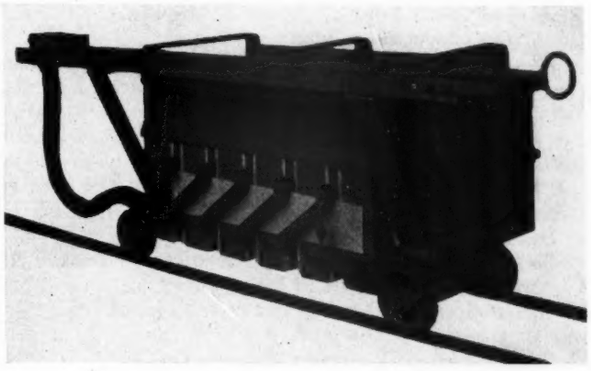
Berwick Electric Bar Heater

A 6-FT. electric bar heater, capable of heating any diameter bar from ⅜ in. up to 1¾ in. and having an adjustment of approximately 6 in. variation in length has recently been brought out by the American Car & Foundry Company, New York. This a.c.f. Berwick electric heater can be built for heating any length stock from 2 ft. or 3 ft. up to 8 ft., 10 ft. or 12 ft. A greater adjustment than 6 in. in variation of length can be arranged so that the length of stock can vary at least 18 in. It is designed to heat a 1-in. bar 6 ft. long to 1,900 deg. F. in one minute. Smaller diameters can be heated in shorter periods of time and larger diameters in a correspondingly longer period of time.

The complete unit weighs approximately 5,000 lb., is 2 ft. in width, 7 ft. 6 in. in over-all length and stands about 3 ft. high. The unit itself consists of a large capacity transformer having a low-voltage secondary capable of carrying high amperage. It is single phase and, as it is designed to heat but one bar at a time, there is but one pair of secondary leads to the ends of which large copper blocks are fastened, these lying in the same horizontal plane.

The bar to be heated is placed between the secondaries, but resting on top of a fire-brick floor, which also represents the roof or protection over the top of the transformer. One end of the secondary above referred to is stationary and the other is movable to allow for expansion, difference in length of bars and other adjustments such as are necessary.

The entire unit is mounted on wheels, making it in a measure portable. Insofar as the heater itself is

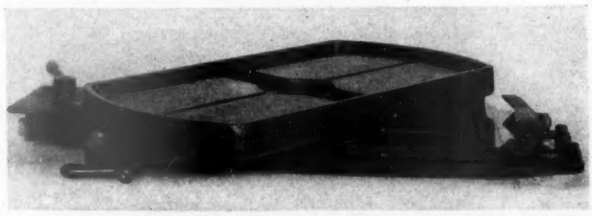


The A.C.F. Berwick electric bar heater

merely a transformer having a low-voltage secondary, material used in its construction, is of necessity silicon steel and copper wire. It can be used for heating stock for hand-feed rivet- or bolt-making machines, bending or upsetting purposes or work of a similar nature.

B. & S. Standard Index Bases

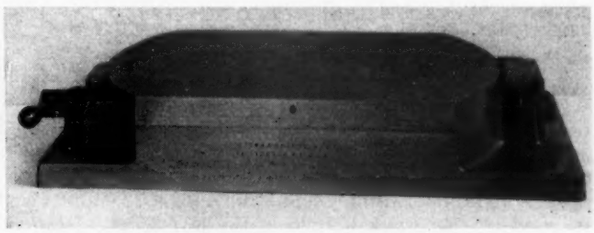
BROWN & Sharpe Manufacturing Company, Providence, R. I., announces the addition of the Nos. 2 and 13 Standard index bases to its line of milling machine attachments. These attachments are designed



The B. & S. No. 13 Standard index base

primarily for use on the Brown & Sharpe plain milling machines which possess automatic or semi-automatic table movements. Both sizes are similar in general design and operation. They consist of a heavy base, bolted to the table of the machine, on which is mounted a swivel. The swivel rotates on a heavy pivot and is locked and held rigidly in position by a taper plunger operated by a hand lever. It can be indexed through 360 deg. with working positions at 0 deg. and 180 deg. The contact surfaces are scraped to assure correct alinement and rigidity. Various types of fixtures, both regular and special, are adaptable for use with these attachments.

The bases are furnished with a reversible tongue for alining them on the table of the milling machine. A tongue slot for the alining fixtures is cut on the swivel. These fixtures are bolted and doweled to the swivel



The B. & S. No. 2 Standard index base

in accordance with the requirements of the job to be done.

One of the bases is designed for use on jobs when semi-automatic table movements are used, where the loading time is equal to or greater than the cutting time. It is arranged with a fixture at each end of the swivel and while the work in one fixture is being milled, the fixture on the other end is being loaded. Upon completion of the cut, when the table returns to

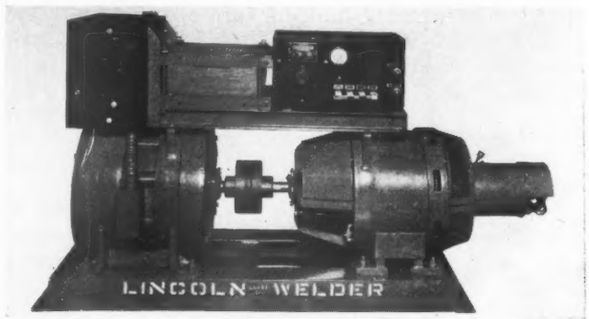
the loading position, the swivel is indexed bringing the fixture on the opposite end into working position, and the machine is again set in operation. The work is then removed from the fixture on which the cut has just been made and it is reloaded preparatory to beginning the next cycle.

A 600-Amp. Lincoln Welder

A WELDER with a rating of 600 amps. has recently been placed on the market by the Lincoln Electric Company, Cleveland, Ohio.

This welder was developed as a result of a demand for higher welding current to be used with large size metallic and carbon electrodes. It is also used to supply current for the Electronic Tornado, a process of automatic carbon arc welding. It is a motor-driven, single-operator, variable-voltage machine and has a current range of from 180 to 750 amp. It may be furnished in either the portable-truck type or stationary type.

The motor and generator are directly connected. The working mechanism of all controls is contained in a ventilated enclosed steel cabinet with hand regulators and switches mounted on a panel which forms a side of the cabinet. The control panel contains rheostat. diverter switch, safety starter switch, volt-ammeter and wing-nut terminals for cables. This unified control is designed to increase the simplicity of the operation of the welder. The control cabinet is mounted directly over the motor generator for easy access. This also permits the removal of the motor generator armature,



The 600-amp. Lincoln welder

without disturbing any of the other parts of the machine.

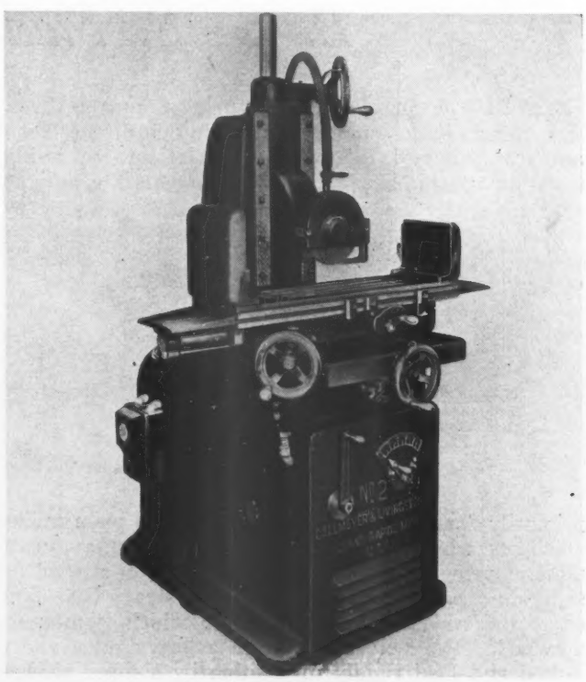
Improved Hydraulic-Feed Surface Grinder

GALLMEYER & Livingston Company, Grand Rapids, Mich., has brought out a surface grinder which has hydraulic feed applied to the table and which is designated by its manufacturers as its No. 2 grinder. The machine is designed so that the control lever on the front of the base at the upper right-hand corner will give an infinite variation in speeds from a stopped condition up to 60 ft. or more per min. Cross feed can be varied from .01 in. to .125 in. and this can be made to operate at either end of the stroke or at both ends of the stroke, as desired. The cross feed is also operated hydraulically.

When the automatic hydraulic feed is in operation, the hand wheel and pinion for hand operation of the table is disengaged. When it is to be operated by hand, the piston-rod connection to the table is disconnected so that the hand movement has no drag upon it, power applied by a spiral pinion giving a maximum smoothness of hand operation. Table movement is started and stopped by the crank handle at the left of the front of the base.

The base and upright ways for the head are designed as one piece to insure maximum rigidity and permanence of alinement between the spindle bearings and the table. The base houses the motor, the hydraulic pump with its control valve, and the oil tank with its supply of oil for the hydraulic operation.

The head ways are protected from dust and dirt and are balanced so as to obviate the danger of the head hanging up and then dropping too far while operating. The elevating screw is directly central between the ways, eliminating any cramping action sideways. The



The Gallmeyer & Livingston grinder now has hydraulic feed applied to the table

weight of the head to the rear of the ways, plus the

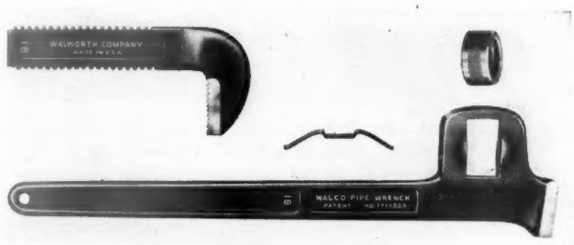
weight of the idler jack which is transmitted to the head by the down pull of the belt, is almost exactly the same as the weight of the head in front of the ways, thus eliminating any cramping action from front to back.

The illustration shows the machine arranged for wet grinding, but with the front and rear table splash guards removed so as to show the working surface of the table. It can be furnished with a dust-collecting system if it is considered desirable by the road.

A wheel 8 in. in diameter with a ½-in. face is the standard size carried, but the spindle is sufficiently large and rigid so that variations from standard are feasible. The machine has a capacity for grinding work 9½ in. thick under the standard 8-in. wheel. A cross feed of 6½ in. is provided so that a wheel ½ in. wide will clear the working surface of the table on both sides.

Walco Tool-Steel Pipe Wrench

A PIPE wrench of drop-forged high-carbon tool steel, designed to provide maximum strength by proper distribution of metal, has recently been placed on the market by the Walworth Company, New York. The wrench consists of four parts: the jaw, the bar, the nut and an alloy-steel spring which provides double action on the jaw and which can be removed and replaced without the aid of tools. The jaw housing, forged as one piece with the bar, is designed to protect the nut against damage and loss of adjustment. The nut is of new design, being provided with a raised surface on each side of the knurl to protect it from battering. The threads on the jaw of the wrench have rounded crests designed to resist damage and to avoid jamming inside the nut. The teeth are heat-treated to impart to them the correct combination of hardness and strength. They are of such a design that they can be reground with an emery wheel to restore their original sharpness.



The wrench is comprised only of four parts

The wrench is made of drop-forged, high-carbon tool steel

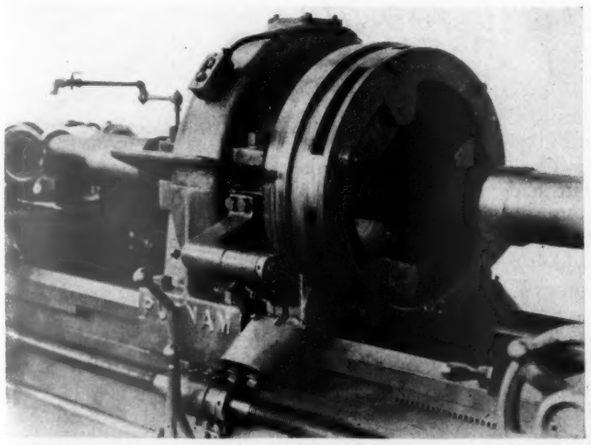
The Powell Chuck for Axle Lathes

MANNING, Maxwell & Moore, New York, is now equipping its Putnam standard axle lathe with a Powell chuck. This device is a three-jaw self-centering positive driver fastened to the center driving head of the machine, and consists of two equalizing plates, three driving jaws, a jaw-operating ring gear and two sets of supporting rollers or centering devices.

The equalizing plates are so arranged as to permit float in two directions and allows the jaws to adjust themselves to axles which are out of round or axles on which the central portion is not concentric with the journals to be turned. The equalizing plates have no friction devices to keep them in place. This is to permit the plates to float to produce journals which will be true with the wheel fit.

The jaws are carried on large-sized studs and are actuated simultaneously by means of an internal ring gear engaging with the tools. The ring gear is provided with bar holes for setting the jaws against the work after loading, whereupon they grip and drive when the tool begins to cut.

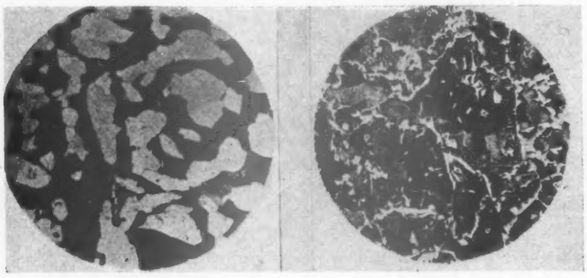
The equalizing-plate supporting rollers are fastened to the head, their function being to support the plates in a central position when loading. The roller arms are provided with spring adjustment so that they can be carefully set up and readjusted in case this becomes necessary. Regular equipment includes three sets of jaws to cover the range of M C B standard axles from 3¾ in. by 7 in. to 6½ in. by 12 in., inclusive.



The Powell chuck application to the center driving head of a Putman axle lathe

Univan Heat-Treated Steel Castings

THE Union Steel Casting Company, Pittsburgh, Pa., has recently developed a cast steel known by the trade name of Univan which has been brought out to meet the demand for a higher strength steel for locomotive construction where toughness is a factor of primary value, together with machinability and shock-resisting capacity. Univan steel, according to tests, has a yield point equal to a minimum of 70 per cent of the tensile strength with relatively high elongation and reduction of area.



Left: Univan steel as cast—Right: The structure after the first state of heat treatment

For the purpose of comparison, the following excerpts from physical tests show the relative characteristics for yield point, tensile strength, elongation and reduction of area of straight carbon, and Univan steel:

CARBON STEEL

Yield point lb. per sq. in.	Tensile strength lb. per sq. in.	Elongation per cent	Reduction of area per cent
38,500	76,000	29.5	51.4
38,440	75,390	27.5	45.4
38,250	76,500	27.0	46.3
39,440	78,385	25.0	47.8
37,440	73,395	27.5	48.3

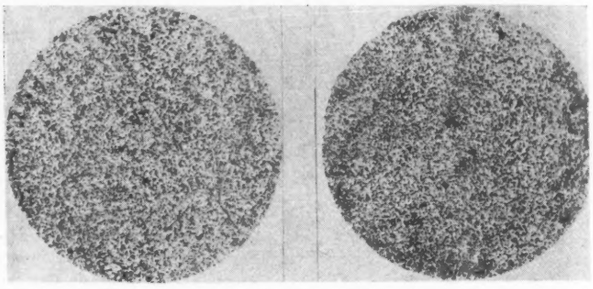
UNIVAN STEEL

Yield point lb. per sq. in.	Tensile strength lb. per sq. in.	Elongation per cent	Reduction of area per cent
64,500	88,870	27.0	56.0
63,700	89,870	27.5	59.1
60,910	86,120	28.5	60.3
63,160	86,120	29.0	62.6
62,910	88,870	27.5	64.0

It will be noted that the yield point in Univan steel is considerably higher than carbon steel while at the same time there is no decrease in elongation. The reduction of area is considerably increased.

The alloying elements used in the manufacture of Univan steel are said not to form carbides, resulting in a material free from hard spots which present a difficult problem in machining.

This steel is said to respond readily to heat treatment and the records of physical tests in the table show the characteristics of the steel after each stage of heat treatment:



The structure of Univan steel after the second and final heat treatments, left and right, respectively

Physical Tests of Univan Steel, Taken After Each Treatment

Treatment	Yield point lb. per sq. in.	Tensile strength lb. per sq. in.	Elongation per cent	Reduction of area per cent
No treatment	68,250	98,750	15.0	16.7
First treatment	70,000	122,000	20.0	45.7
Second treatment	73,000	95,750	27.5	54.4
Final treatment	66,750	91,750	28.0	57.6

The illustrations accompanying this article show microphotographs of the structure of the steel before and after each stage of heat treatment.

Univan cast steel has been developed especially for the manufacture of locomotive castings that are subject to unusual and continuous shocks such as locomotive frames, driving-wheel centers, crossheads, eccentric cranks, driving boxes and other locomotive parts subject to severe operating conditions.

An Adjustable Template

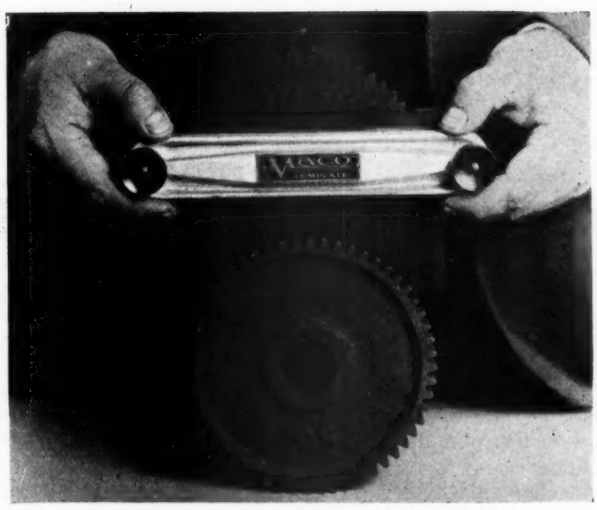
AN adjustable template, designed for making awkward measurements or taking the contour of irregular shapes, has been put on the market and appears to have a number of applications in the railway field, particularly for determining the contour of rails, wheels, locomotive tires, crank pins and other wearing parts or surfaces. This template, which is of English manufacture and which is distributed by the American Maco Template Company, 44 Whitehall street, New York, is known as the Maco Template, and consists essentially of a substantial aluminum frame or housing, carrying a sheath of fine strips or laminae of hard-drawn brass, in which the individual lamina are capable of longitudinal movement entirely independent of each other.

The laminae are each 0.007 in. in thickness and are held in position in the frame by special clamps fitted with sections of corrugated rubber, which prevent the laminae from falling out when being moved to the desired positions in the frame by the operator.

The templates are furnished in three types of different sizes, known as types 3, 4 and 5. Type 3 will take contours over a width of 6 in., type 4 over a width of 9 in., and type 5 over a width of 12 in. The depth to which contours may be taken with the different types ranges from 3 in. for the type 3 template to 3½ in. for the type 5 template. Aside from their size, the main difference in the different types is the clamping arrangment for holding the laminae in alinement. The three smaller types have only one clamp plate over the laminae with thumb screws at each end to secure it to the frame, while the 12-in. template has a double-bar clamp with four thumb screws, in order to provide a greater bearing on the longer laminae. In addition,

the 12-in. template has a sliding guide bar across the front face of the instrument, which assists in maintaining the long laminae in correct position while contours are being taken. The different type templates range from 1/16 in. to ⅛ in. in thickness and weigh from 8 oz. to 24 oz., depending upon the size of each of the templates.

In applying the templates, it is only necessary to loosen the clamps and to press the template against the contour to be taken. The result of this pressure is that the laminae take an exact outline of the surface against which they are pressed, their extreme thinness assisting materially in the facility and precision of the process. When the laminae have assumed the contour of the surface being measured, locking of the clamp screws holds them securely in position. From the template thus produced card records can be made for measurements and for permanent records. The 12-in. template is said to have been used effectively in measuring the contour of worn wheels and in obtaining information with regard to the wear and deformation of frogs and crossings in track.



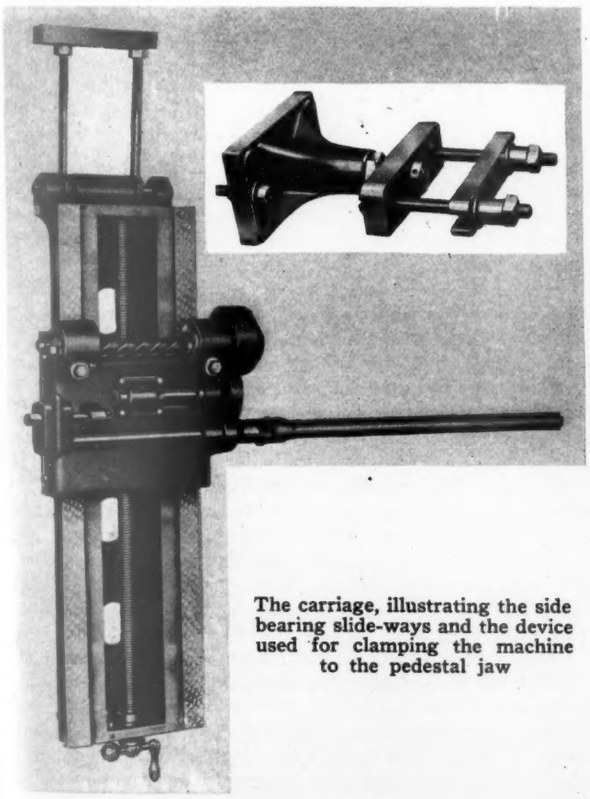
The Maco adjustable template, the laminations of which are capable of independent longitudinal movement

Frame-Jaw Milling Machine

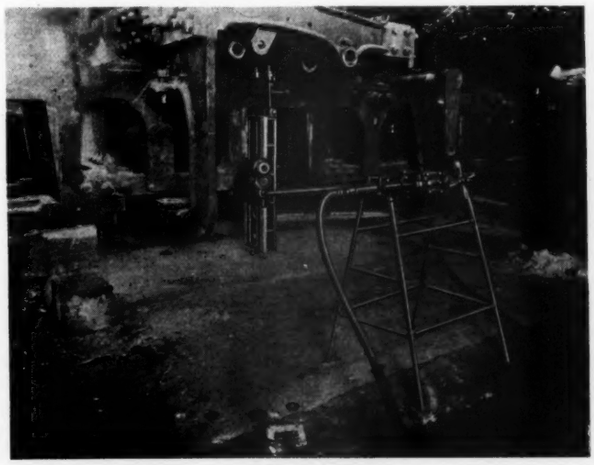
THE Micro Machine Company, Bettendorf, Iowa, has developed a frame-jaw milling machine which straightens concave or worn faces of frame jaws and mills the surplus metal left after welding, milling the full length of the jaw face together with the top radius. It is designed to mill jaw faces up to 7 in. wide by 32 in. long. The machine consists of a carriage and a main slide frame, the slide-ways of which are 11 in. wide by 40 in. long. The carriage has wide bearing on the slide-ways and is provided with a take-up gib and lubricating facilities. The cutter feed is of eccentric design for increasing the depth of the cut. The carriage feed is driven by a power feed screw or by a hand crank.

In setting up the machine, a line is scribed on the side of the jaw with a square from the top of the frame, after which a mounting bracket which secures the lower end of the device to the frame is adjusted until the cutter carriage slideways are parallel with this line. For the wedge side, the same procedure is followed except that an angular line is scribed. After the set-up has been completed, the spiral cutter is adjusted to the pedestal face by means of eccentric bearings that are locked by two screws after the desired depth of cut has been accomplished.

The machine is driven by a 300-r.p.m. pneumatic



The carriage, illustrating the side bearing slide-ways and the device used for clamping the machine to the pedestal jaw



The milling machine set up complete

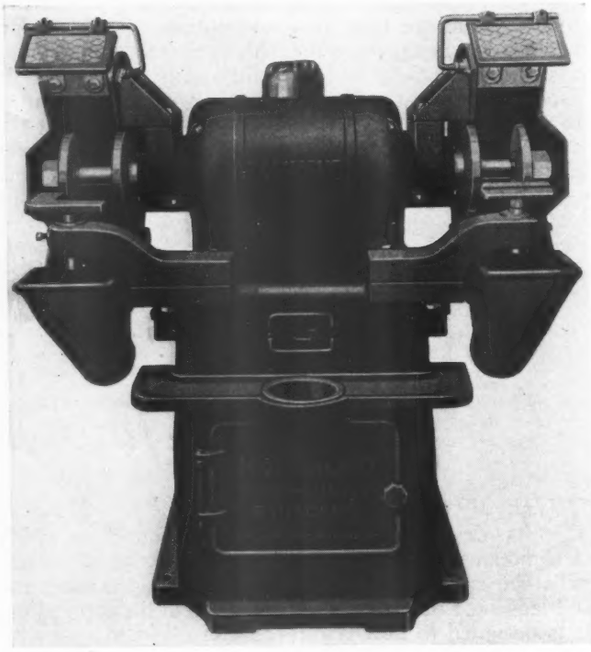
motor mounted upon a stand made of round iron welded at the corners. The motor drives the machine by means of a 6-ft. telescoping shaft which is equipped with universal joints.

Hammond Heavy-Duty Grinder

A *HEAVY*-duty grinder intended for continuous production service for heavy tool grinding has recently been placed on the market by the Hammond Machinery Builders, Kalamazoo, Mich. It is made in 5-hp. and 7½-hp. capacity sizes, the outstanding feature of the machine being the totally enclosed 40-deg. Centigrade motor, fitted wih a motor air cleaner designed to eliminate grit and dirt from the motor windings.

These machines are equipped with push-button control and a Cutler-Hammer automatic motor starter, having thermal overload protection, low-voltage, and phase-failure protection. The automatic starter is mounted on the inside of the pedestal door for convenience of inspecting and resetting. Oversize ball bearings are protected from dirt and dust by labyrinth seals. The oilers for the bearings have oil level gages and flushing plugs, making it possible to cleanse the bearings without dismantling the machine.

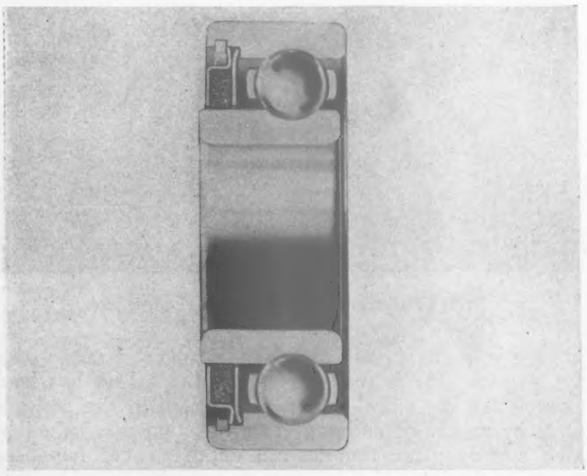
The spindle is made of chrome-nickel steel, accurately ground and balanced. The wheel guards are made of boiler-plate steel and comply with the American Standards Association specifications. They have hinged doors for the quick removal of grinding wheels and are equipped with spark shields and shatterless-glass eye shields which are adjustable to compensate for the wear tool rests are standard equipment.



The Hammond 7½-hp. grinder for heavy-duty work

Felt-Seal Ball Bearing

S *K F* Industries, Incorporated, New York, has developed a felt-seal ball bearing possessing a number of distinctive features which mark it as an improvement in this type of bearing. A felt seal is provided as an integral part of the bearing, thus making it necessary for the machine manufacturer to provide only one housing enclosure.



The S K F felt-seal ball bearing

The outer and inner races, as well as the balls in the S K F felt-seal bearing, are made of high-carbon, chrome-alloy steel, hardened throughout. The bore and outside diameter are ground to international standard dimensions and tolerances, the same as the corresponding standard single-row bearings. The width, however, is slightly greater than the standard dimension of a single-row bearing in order to accommodate the felt seal. The tolerances on eccentricity of the outer and inner races are also international standard tolerances for single-row ball bearings.

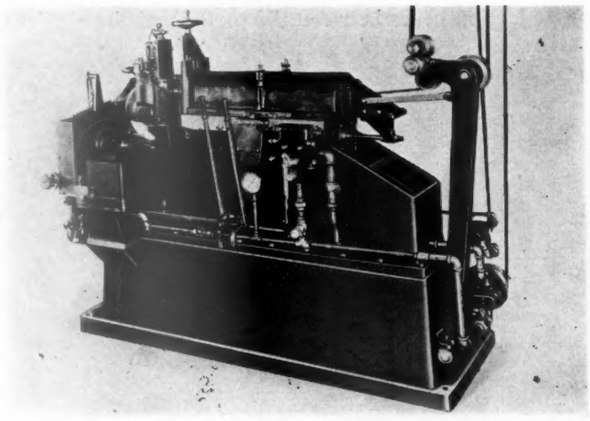
The inner race projects slightly beyond the face of the seal in order that the bearing may be pulled off the shaft at any time without the possibility of damaging the seal plates.

The seal consists of an inner steel plate which is dished at its periphery and bears against a shoulder formed on the outer race. A removable felt of substantial size comes next, then a dished-steel end plate, after which a split steel ring is fitted into a groove in the outer race to hold the assembly in place.

An outstanding feature of the design is the ease with which the seal may be disassembled at any time and new felts applied. To disassemble the seal, it is merely necessary to spring the split-steel ring out of the groove in the outer race, after which all the other component parts of the seal may be readily lifted out.

The Garrison Gear Grinder

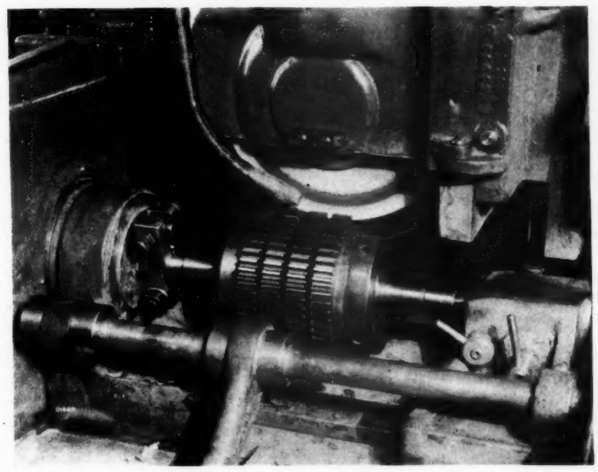
THE Garrison gear grinder of the Pratt & Whitney Company, Hartford, Conn., is a 9-in. hydraulic grinder designed for finishing gear teeth to close limits by generation, for standard manufacturing and for salvaging gears. When in operation, a



The Garrison 9-in. hydraulic gear grinder

reciprocating horizontal ram, somewhat similar to that of a horizontal shaper, carries the grinding wheel back and forth through the teeth, grinding adjacent sides of two teeth at once. The wheel is trued up with straight sides corresponding to the shape of a master rack. The gears being ground are rolled past the wheel under the guidance of a master gear and rack, so that the wheel engages the work in exactly the same manner that a given tooth of the master rack engages the master gear. The wheel makes as many passes per tooth as are necessary for the finish desired. When the work has rolled to the opposite side of the wheel and out of engagement with it, the rack is lifted out of the master gear, the latter indexed one tooth, and the rack re-engaged automatically. When the work has been indexed one complete revolution, the machine stops automatically.

Wheel dressing is accomplished by a built-in device which passes a diamond along both sides and the top of the wheel, producing the correct angles. The wheel is kept in the same position relative to the work regardless of wheel truing. The ram of the grinder and the feed are hydraulically operated to eliminate reversing

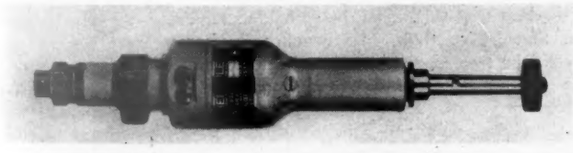


The machine grinds adjacent sides of two teeth in one operation

shocks and to produce a smooth positive drive easily adjustable by a valve to any speed within its range.

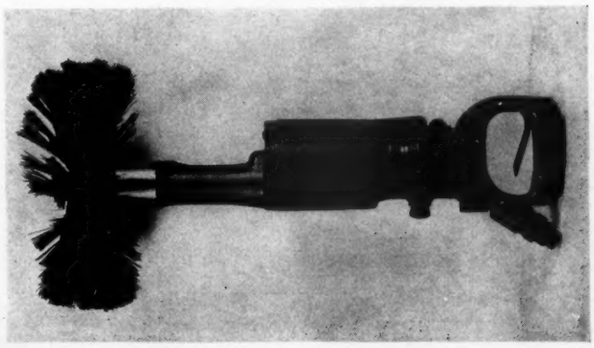
Hercules Grinders and Nut Setter

THE Buckeye Portable Tool Company, New York, has recently placed on the market its models, No. 113-3 and No. 315-4 grinders and its No. 017-5 right-



The Hercules No. 113-3 grinder

angle nut setter. The No. 113-3 grinder is designed for use with small emery wheels, emery pencils, rotary files, etc., and for use in very close quarters. It weighs



The Hercules No. 315-4 wire brush and grinder

3½ lb. and runs at a free speed of 22,000 r.p.m. The throttle and rear head of the grinder is cast in one piece and with the extension shaft off it measures 12 in. in length.

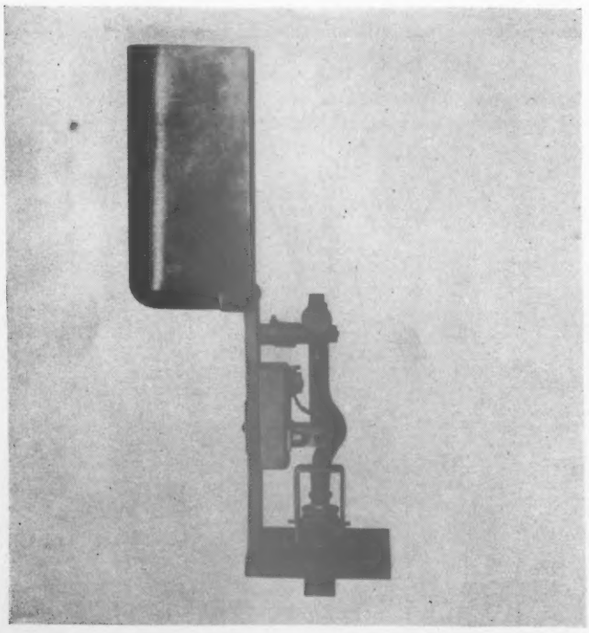
The No. 315-4 wire brush and grinder is built on the principle of the Buckeye No. 300 series and is governor-controlled. It is designed for heavy-duty grinding, wire brushing, snagging and buffing. One of its chief uses is for brushing scale and rust on steel cars and similar surfaces. It can be furnished in speeds of 2,000, 3,100 and 4,000 r.p.m. and weighs 13 lb.

The No. 017-5 right-angle nut setter

The nut setter is designed for close-quarter work. It is furnished in two speeds, 660 r.p.m. and 1,000 r.p.m., and is intended for setting ½-in. nuts and 5/8-in. cap screws. The tool is 21 in. long and weighs 11¼ lb.

Thermostat Control for Melting Pots

THE General Electric Company, Schenectady, N. Y., has placed on the market a quartz-rod thermostat for controlling the temperature of metal-melting pots for use with lead, tin, babbitt, solder, etc. The thermostat consists of an enclosed switch and a nickel-chrome iron tube extending from its base and surrounding a steel piston and quartz rod. It has a temperature range of 450 to 950 deg. F. and will control temperatures to within plus or minus 14 deg. F. of its setting. The contacts are designed to carry any current necessary to operate any standard automatic control panel.

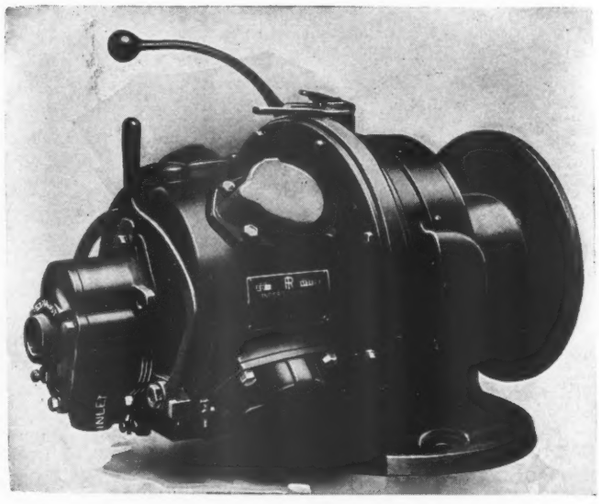


The G.E. quartz-rod thermostat for metal-melting pots

A Portable Air Hoist

THE Ingersoll-Rand Company, 11 Broadway, New York, has recently added to its line of portable air hoists one of 2,000 lb. capacity. This hoist employs a radial, four-cylinder, counterbalanced, reciprocating-piston air motor, which is reversible. All wearing parts and cylinders are renewable and the cylinders are interchangeable.

Reduction gears between the motor and the air drum are heat-treated, machine-generated spur gears. These gears are completely enclosed in a housing which excludes all dust and which serves as a container for semi-fluid grease in which the gears operate. The hoists are of light-weight construction which permits them to be readily moved from place to place and to be bolted to a timber or mounted on a post or steel column in any convenient location.



A portable air hoist of 2,000 lb. capacity

THE CANADIAN NATIONAL, it seems, has tried out a new locomotive which generates its own electricity, hauls a heavy train at 75 miles an hour and saves some incredible amount in the cost of fuel. Of these things, unfortunately, we do not feel qualified to speak. But the fact that the new locomotive is "resplendent in silver-gilt finish," we feel, lies right up our alley. For this is something about which we have had quite a lot to say in the past, and happily to some effect—though we will admit that this might be coincidence. After we had pointed out that locomotives, like coaches, brakemen and conductors, should be togged out in gaudy hues, several roads, among them the Baltimore & Ohio, began togging them out that way, achieving great beauty. We are glad to learn that the Canadian National has followed suit. It should never be forgotten that a railroad train is a magnificent thing. It is going somewhere, bound for an enchanted spot beyond the horizon. Thus it should have at the head of it no grimy thing of black, but a machine of gala appearance. We look forward to the time when all locomotives will be made of silver, with solid gold wheels.—New York World.

Among the Clubs and Associations

THE AMERICAN RAILWAY ASSOCIATION has joined in the underwriting of the finances of the American Standards Association, according to an announcement recently made by W. J. Serrill, president of the A. S. A. The American Railway Association will contribute $15,000 per year for the three-year period of the underwriting. A total of $150,000 per year has been made available through the underwriting to promote the work of the A. S. A. in the establishment of national industrial standards. Among other organizations which have joined in the underwriting are the Aluminum Company of America, Bethlehem Steel Company, General Electric Company, U. S. Steel Corporation, Westinghouse Electric & Manufacturing Company, and the Youngstown Sheet & Tube Company.

New York Railroad Club Annual Outing

The New York Railroad Club held its annual outing on July 10, and about 620 members and their guests were present, the steamer "Alexander Hamilton" of the Hudson River Day Line having been chartered for the occasion.

The steamer left pier 81 at the foot of West Forty-Second street, New York, at 1 p.m. and from that time until dusk cruised continuously on the Hudson river. No landing was made from the time the boat sailed until she docked at 9:30 p.m. A buffet luncheon was served and a dinner at 6:30 p.m.

The entertainments provided for the visitors were many and varied including deck sports, and for golf enthusiasts there was an outdoor obstacle golf game of pitch and putt; while long drivers were invited to show their prowess on the golf driv-o-meter. Other games included ring toss, Bristle target practice, deck and shuffle board, cane toss, a kiddy-kar race, a horse race conducted on the pari-mutual system, cards, etc., the order of the day being to round up one's own party and play as one pleased.

Music was furnished by the Blue Comet Band from Wilkes-Barre, Pa., by courtesy of the Central of New Jersey, which band throughout the cruise furnished lively tunes and added color with their dashing blue uniforms. Frank Hedley, president of the Interborough Rapid Transit, acted as master of ceremonies and song leader.

Among the winners of the prizes consisting of golf bags, traveling kits, clocks, canes, etc., were: George W. Galloway, vice-president B. & O.; H. H. Vreeland, chairman, executive committee, New York Railroad Club; C. C. Hubbell, purchasing agent of the D. L. & W.; W. C. Gove, Brooklyn-Manhattan-Transit; George Le Boutillier, vice-president, Long Island and the Pennsylvania; James Egan, stationmaster, Pennsylvania; J. S. Doyle, Sr., Interborough; E. M. Herr, vice-chairman, Westinghouse Electric & Mfg. Co., and George F. Mand, assistant secretary, American Car & Foundry Company. On Tuesday, August 12, the Railroad Club will hold a golf tournament in the vicinity of New York.

TOOL FOREMEN'S CONVENTION.—On September 10, 11 and 12, the eighteenth annual meeting of the American Railway Tool Foremen's Association will be held at the Hotel Sherman, Chicago, with President A. A. Ferguson, tool supervisor, Missouri Pacific, St. Louis, Mo., in the chair. The details of the program are as follows:

WEDNESDAY, SEPTEMBER 10

9:30 a. m.

Opening exercises
Address by O. A. Garber, chief mechanical officer, Missouri Pacific, St. Louis, Mo.
Response by C. A. Shaffer, general supervisor of shop machinery and tools, Illinois Central, Chicago
Address by President A. A. Ferguson, tool supervisor, Missouri Pacific, St. Louis, Mo.
Report by Secretary-Treasurer G. G. Macina, Chicago, Milwaukee, St. Paul & Pacific, Chicago
Appointment of Committees

2:00 p. m.

Address on Forging Machine Dies, by H. N. Anderson, Acme Machinery Company, Cleveland, Ohio
Report of Standing Committee on Tools and Methods for Mass Production, by Chairman M. B. Roderick, assistant supervisor of tools and machinery, Erie, Meadville, Pa.
Adjournment

THURSDAY, SEPTEMBER 11

9:30 a. m.

Address on Safety First, by H. Guilbert, director of public safety, Pullman Company, Chicago
Response by E. J. McKernan, supervisor of tools, Atchison, Topeka & Santa Fe, Topeka, Kan.
Address on Heat Treatment of Steel, by Alexander H. d'Arcambal, Pratt & Whitney Company, Hartford, Conn.
Report of Standing Committee on Tools for Maintaining Automotive Equipment, by Chairman W. H. Smith, tool supervisor, Missouri Pacific, Little Rock, Ark.
Election of officers

FRIDAY, SEPTEMBER 12

9:30 a. m.

Report of Standing Committee on Testing Devices for Pneumatic Tools and Jacks, by Chairman C. B. Heingarten, tool foreman, Chicago & North Western, Chicago
Report of Standardization Committee, E. J. McKernan, chairman
Closing business

Directory

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations and railroad clubs.

AMERICAN RAILWAY ASSOCIATION.—DIVISION V.—MECHANICAL.—V. R. Hawthorne, 59 East Van Buren street, Chicago.

DIVISION V.—EQUIPMENT PAINTING SECTION.—V. R. Hawthorne, Chicago. Next meeting, Sept. 9-11, 1930, Congress Hotel, Chicago.

DIVISION VI.—PURCHASES AND STORES.—W. J. Farrell, 30 Vesey street, New York.

DIVISION I.—SAFETY SECTION.—J. C. Caviston, 30 Vesey street, New York.

DIVISION VIII.—CAR SERVICE DIVISION.—C. A. Buch, Seventeenth and H streets, Washington, D. C.

AMERICAN RAILWAY TOOL FOREMEN'S ASSOCIATION.—G. G. Macina, 11402 Calumet avenue, Chicago. Next meeting, September 10, 11 and 12, Hotel Sherman, Chicago.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—Calvin W. Rice, 29 W. Thirty-ninth street, New York.

RAILROAD DIVISION.—Paul D. Mallay, chief engineer, transportation department, Johns-Manville Corporation, 292 Madison avenue, New York.

MACHINE SHOP PRACTICE DIVISION.—Carlos de Zafra, care of A. S. M. E., 29 West Thirty-ninth street, New York.

MATERIALS HANDLING DIVISION.—M. W. Potts, Alvey-Ferguson Company, 1440 Broadway, New York.

OIL AND GAS POWER DIVISION.—L. H. Morrison, associate editor, Power, 475 Tenth avenue, New York.

FUELS DIVISION.—A. D. Black, associate editor, Power, 475 Tenth avenue, New York.

AMERICAN SOCIETY FOR STEEL TREATING.—W. H. Eiseman, 7016 Euclid avenue, Cleveland, Ohio.

AMERICAN SOCIETY FOR TESTING MATERIALS.—C. L. Warwick, 1315 Spruce street, Philadelphia, Pa.

BOILER MAKER'S SUPPLY MEN'S ASSOCIATION.—Frank C. Hasse, Oxweld Railroad Service Company, 230 N. Michigan avenue, Chicago. Meets with Master Boiler Makers' Association.

CAR FOREMAN'S ASSOCIATION OF OMAHA COUNCIL BLUFFS AND SOUTH OMAHA INTERCHANGE—Geo. Kriegler, car foreman, Chicago, Burlington & Quincy, Sixteenth avenue and Sixth street, Council Bluffs, Iowa. Regular meetings, second Thursday of each month at Council Bluffs, Iowa.

CAR FOREMEN'S CLUB OF LOS ANGELES.—J. W. Krause, 514 East Eighth street, Los Angeles, Cal. Meetings second Friday of each month in the Pacific Electric Club building, Los Angeles, Cal.

EASTERN CAR FOREMEN'S ASSOCIATION.—E. L. Brown, care of the Baltimore & Ohio, Staten Island, N. Y. Regular meetings fourth Friday of each month.

INTERNATIONAL RAILROAD MASTER BLACKSMITH'S SUPPLY MEN'S ASSOCIATION.—J. H. Jones, Crucible Steel Company of America, 650 Washington boulevard, Chicago.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.—C. T. Winkless, Room 707, LaSalle Street Station, Chicago.

INTERNATIONAL RAILWAY GENERAL FOREMEN'S ASSOCIATION.—William Hall, 1061 W. Wabasha street, Winona, Minn. Next meeting, September 16 to 19, inclusive, Hotel Sherman, Chicago.

INTERNATIONAL RAILWAY SUPPLY MEN'S ASSOCIATION.—L. R. Pyle, Locomotive Firebox Company, Chicago. Meets with International Railway Fuel Association.

MASTER BOILERMAKER'S ASSOCIATION.—A. F. Stiglmeier, secretary, 29 Parkwood street, Albany, N. Y.

MASTER CAR BUILDERS' AND SUPERVISORS' ASSOCIATION.—A. S. Sternberg, master car builder, Belt Railway of Chicago. Next convention August 26-28, Book-Cadillac Hotel, Detroit.

PACIFIC RAILWAY CLUB.—W. S. Wollner, P. O. Box 3275, San Francisco, Cal. Regular meetings, second Tuesday of each month in San Francisco and Oakland, Cal., alternately.

PUEBLO CAR MEN'S ASSOCIATION.—I. F. Wharton, chief clerk, Interchange Bureau, Pueblo, Colo.

RAILWAY BUSINESS ASSOCIATION.—Frank W. Noxon, 1124 Woodward building, Washington, D. C.

RAILWAY CAR MEN'S CLUB OF PEORIA AND PEKIN.—C. L. Roberts, chief clerk, Peoria & Pekin Union Railway, 217 Lydia avenue, Peoria, Ill.

RAILWAY SUPPLY MANUFACTURERS' ASSOCIATION.—J. D. Conway, 1841 Oliver building, Pittsburgh, Pa. Meets with Mechanical Division and Purchases and Stores Division, American Railway Association.

SUPPLY MEN'S ASSOCIATION.—Bradley S. Johnson, W. H. Miner, Inc., Chicago. Meets with Master Car Builders and Supervisors' Association.

NEWS

NEW YORK, NEW HAVEN & HARTFORD.—This company has authorized an expenditure of $40,000 for the provision of additional fire protection at its shops at New Haven, Conn.

THE SOUTHERN has awarded a contract for the construction of a water treating plant at Shelbyville, Ky., to the R. D. Cole Manufacturing Company, Newman, Ga.

A COMPLAINT of the Brotherhood of Locomotive Firemen and Enginemen against the operation of gas-electric rail cars by the Wheeling & Lake Erie on its Toledo-Zanesville line without "full crews" was dismissed by the Public Utilities Commission of Ohio on June 17.

Banquet is Staged in Enginehouse

ON JUNE 4, the Detroit & Toledo Shore Line celebrated the completion of an installation of direct steaming at its engine terminal in Toledo, Ohio, by staging a banquet in an 8-stall section of the enginehouse. During the dinner and the ceremonies which followed, the remainder of the 24-stall enginehouse was in full operation. One of the special features of the arrangements was the serving of the dinner around two locomotives which were being held under steam, without fires on their grates.

More than 400 invited guests were present, many of whom were officers of the railways entering Toledo. The party also included municipal officers and chiefs of smoke inspection bureaus from Toledo and surrounding cities, and representatives of many of the industries of the city.

The ceremonies began with an automobile parade from the heart of the business district, starting at 5:15 p.m. and ending at the engine terminal where the banquet was served at 6 o'clock. Three features of the installation were noted particularly by the guests: The absence of the familiar smoke jacks; the complete elimination of smoke, steam and gases from the enginehouse; and the fact that the regular lighting system in the enginehouse was adequate for the occasion, so that no supplemental lighting was necessary.

C. G. Bowker, president, D. & T. S. L., presided as toastmaster. Short talks were made by representatives of the manufacturers who had furnished equipment and supplies for the installation and by representatives of the mechanical departments of the railways entering Toledo. Among the latter was Joel De Vault, general foreman, New York, Chicago & St. Louis, who is also president of the Toledo Smoke Abatement League. The principal speaker of the evening was Henry Kreisinger, engineer, Combustion Engineering Company, New York, who, in keeping with the occasion, discussed "What Soot Is, What Causes It and How It Can Be Eliminated or Minimized."

New Equipment

THE RAILROADS of the United States in the first six months of 1930 placed 49,208 new freight cars in service, the Car Service Division of the American Railway Association announced. In the same period last year 32,794 new freight cars were placed in service. Of the total, 26,016 were box cars, an increase of 10,820 compared with such installations in the first half of 1929. There were also 18,343 new coal cars, compared with 11,482 during the same period last year. In addition, the railroads installed 2,963 flat cars; 1,099 refrigerator cars; 487 stock cars, and 300 other miscellaneous cars. The railroads on July 1 this year had 24,649 new freight cars on order, compared with 39,638 cars on the same day last year and 14,659 on the same day two years ago.

The railroads also placed in service in the first six months this year 411 new locomotives, compared with 319 in the same period in 1929. New locomotives on order on July 1 this year totaled 364, compared with 386 on the same day last year and 106 two years ago.

Freight cars or locomotives leased or otherwise acquired are not included in the above figures.

HISTORICAL BULLETIN No. 22 of the society (Baker Library, Boston, Mass.), is dated May, 1930, and priced at two dollars a copy. About half of this issue is taken up with a list of the locomotives of the Boston & Albany beginning with the year 1832, and other matter dealing with the history of this road and the Western Railroad, which was the predecessor company operating the line west of Worcester. The list of locomotives gives the name of each engine, the builder, the year when built, size of drivers, the type, and many of the early names for two or more successive locomotives.

Other material in this bulletin includes a brief account of the railroad track laid across the St. Lawrence River on the ice in 1880, a brief history of the New York & New England Railroad (copied from a report made in 1879) and notes on the centenary of the Liverpool & Manchester.

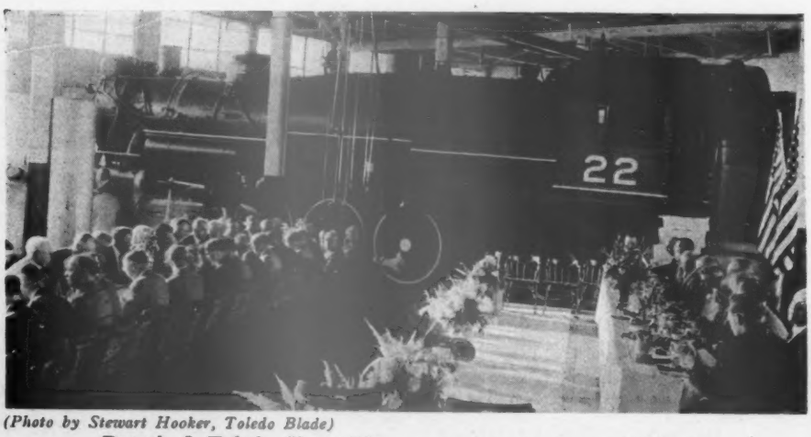
Tank Car Braking Power Adjustment

A CIRCULAR No. D.V.-697, recently issued by the American Railway Association Mechanical Division, calls attention to the generally improved condition of brake power on existing tank cars and states that, owing to the fact that Section H of the Interchange Rule 3 has been adopted covering brake power for all freight cars, the provision of circular S-3-2, issued May 15, 1919, covering the adjustment of brake power on existing tank cars is abrogated. The circular further states that the brake power on existing tank cars should be made to conform to the standard adopted in 1924 on all cars built new and on cars rebuilt after March 1, 1925, in accordance with the provision of Section H of Interchange Rule 3.

General Electric to Stabilize Employment

THE GENERAL ELECTRIC COMPANY announces the adoption of an "unemployment plan" designed to aid employees when business is slack. The money will be raised through equal contributions by the employees and the company. Any one of the company's numerous plants may adopt the plan regardless of the action of other plants. Adoption at any plant depends on a 60 per cent vote of employees at that plant; all employees who have been in the service one year. An employee must agree to contribute one per cent of his earnings so long as he earns 50 per cent of his normal pay. In case of abnormal times of unemployment, normal contributions would cease and all employees would be called upon to contribute.

Provision is made for contributions to a relief fund and a fund for lending to employees, as well as for ordinary unemployment payments. In each plant the management will be by a board of



(Photo by Stewart Hooker, Toledo Blade)

Detroit & Toledo Shore Line serves banquet in enginehouse

from four to sixteen members, half of whom will be appointed by the company. Contributions must be made for six months before benefits will begin to be paid.

On a temporary lay-off, an employee will receive 50 per cent of his average earnings but not more than $20, a week and for not over ten weeks in any 12 consecutive months.

Provision is made for unemployment emergencies when all employees of a plant, whether participants or not, will be called upon to contribute one per cent of earnings. This includes officers as well as workmen.

When business is increasing new men must be added slowly, transfers must be made if possible from less busy departments, and overtime allowed, only as a last resort. When work begins to fall off, overtime must be cut out where possible, the sales department stimulated and employees put to work on standard apparatus for stock. Also the normal week must be cut down gradually, and possibly down to 50 per cent of normal.

Centenary of New England Steam Railroads

THE BOSTON & MAINE, in co-operation with the City of Lowell, Mass., celebrated in Lowell on June 5 the hundredth anniversary of the granting of the charter of the Boston & Lowell Railroad, which was voted by the legislature of Massachusetts on June 5, 1830.

This is called the centenary of New England *steam* railroads, as the Granite Railway, the three-mile line built in Quincy, a few miles south of Boston, in 1826, and which was the first railroad in the United States, was operated by horses and by gravity, and, moreover, was used only for the transportation of granite for the Bunker Hill Monument.

One of the first questions to be determined by the Boston & Lowell was whether or not steam locomotives should be used. The subject of locomotives was thoroughly discussed, but these discussions resulted, after all, so far as records show, in leaving the matter to the discretion of Patrick T. Jackson, one of the leading business men of Lowell, who was elected agent and treasurer of the railroad. Later in 1832, Mr. Jackson reported that he had written to Robert Stephenson of Robert Stephenson & Co. to "send out two of his best locomotive engines." Whether any more detailed specifications were ever prescribed does not appear.

One of the two original engines is depicted on a tablet which has been placed in Lucy Larcom Park, near the site of the first railroad station in Lowell. In searching the ancient records for a suitable description of this locomotive, considerable difficulty was encountered because of doubts as to details. In a collection of pictures in the Lowell Historical Society, there is one showing an engine with two pairs of driving wheels, coupled, which purports to be the first locomotive; but other information is to the effect that the engine had a single pair of drivers in front of the firebox and a pair of leading wheels of smaller size. The engine shown on the tablet has the smaller leading wheels, investigation having shown that the four-coupled arrangement depicts the locomotive at a future date, after the wheel arrangement had been changed. The first locomotives arrived in 1834. No picture or drawing of these is available, but from investigations recently made it appears that a locomotive of the Bangor & Piscataquis, in Maine, built by Stephenson in 1835, was of the same style as those built for the Boston & Lowell. This Bangor & Piscataquis engine is shown in the illustration printed herewith.

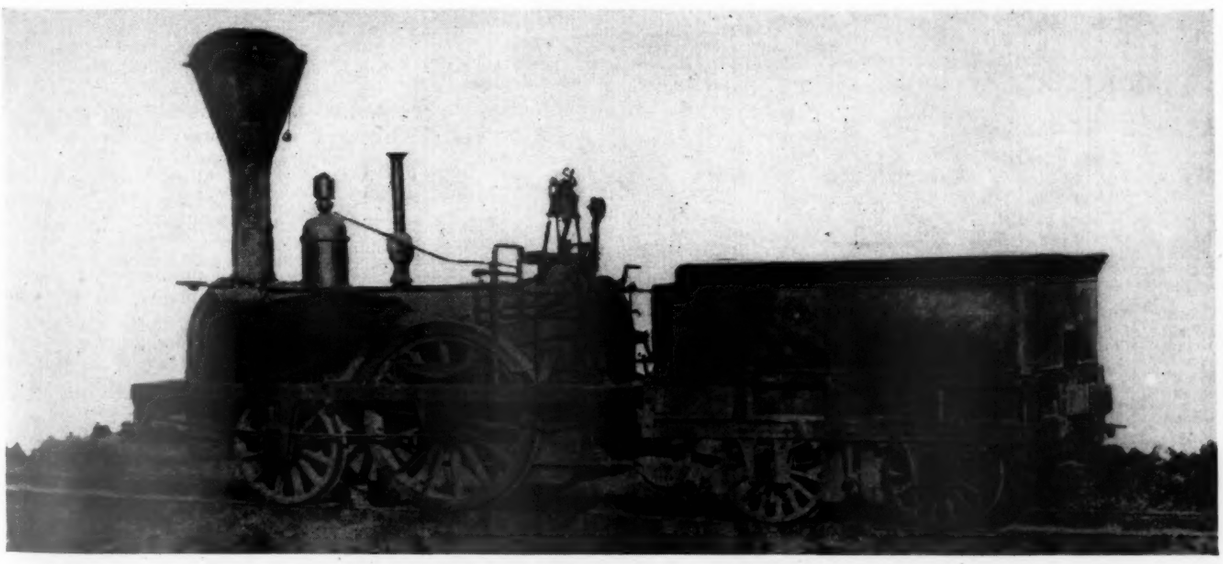
The whole cost of the road (one track) as of October, 1835, was $1,039,105.10, to which was added about $62,000 for tracks to different mills in Lowell, for locomotives and cars and for stations in Lowell and Boston.

Wage Statistics for April and May

CLASS I RAILWAYS reported to the Interstate Commerce Commission a total of 1,572,566 employees as of the middle of the month of April. The total compensation was $225,760,235. Compared with the returns for the corresponding month of last year this shows a decrease in the total number of employees of 93,034, or 5.59 per cent, the total compensation shows a decrease of 6.41 per cent. The commission has also issued its preliminary statement for May showing a total of 1,601,494 employees, a decrease of 6.59 per cent as compared with May, 1929, and a decrease of 6.33 per cent as compared with May, 1928.

"Machine Age" to be Portrayed in Exhibit

UNDER THE AUSPICES of the Museum of the Peaceful Arts, an exhibition depicting the rise of the "machine age" will be held from September 12 to November 15 in the News building 220 East Forty-Second street, New York. The exhibit will be divided into three periods, representing, respectively, machine developments up to the middle of the eighteenth century, the period from that time to about 1900, and developments since the beginning of the present century. The main objectives of the exhibition will be to present the physical agencies of the machine age, the most significant industrial advances which these have brought about and the social and economic significance of these technological improvements.



Type of Locomotive Used at the Opening of the Boston & Lowell, 1835
Built by Robert Stephenson & Co., Newcastle-on-Tyne

Missouri Pacific Hot Box Record

IN DISCUSSING the report of the Committee on Lubrication of Cars at the Mechanical Division, Atlantic City convention in June, O. A. Garber, chief mechanical officer of the Missouri Pacific, was incorrectly reported as saying that the present performance in this important particular on the Missouri Pacific is one-half a hot box per 100 car-miles and on the northern lines .69 hot boxes per 100 car-miles. In each case, these figures should have been expressed as .50 and .69 hot boxes per 100,000 car-miles, respectively.

Shop Crafts Draft Five-Day Week Program

A 40-HOUR WEEK consisting of five eight-hour working days was voted by the Railway Employees' department of the American Federation of Labor at the eighth convention, held recently at Chicago, as the principal point in its plan for the stabilization of employment on the railroads. The 40-hour week of five days would be placed in effect except where continuous operation is necessary, when the day would be divided into a series of shifts, in some instances ranging as high as four. The question of a date for instituting the proposed program was referred to the executive council of the railway department of the Federation.

The other points in the program, which constituted a special report of a committee on job stabilization, were as follows:

Limitation of the number of apprentices to that necessary to meet the needs of the industry.

A two-weeks' annual vacation with pay for all men who have been in service for more than one year.

Establishment of a minimum working force at the beginning of each year, to guarantee each employee at least 12 months of continuous employment, but without interfering with the right of the management to hire additional men.

Performance of as much building and converting of locomotives and cars in railroad shops as possible, and the manufacture, instead of purchase, of parts and other equipment.

Establishment of a maintenance reserve program under which more repair work would be undertaken during periods of reduced business, in order to have cars and locomotives in first class condition to meet all requirements of busy seasons.

The report recommended that "in the adjustment of hours to meet the provisions of the proposed rules, the reduction in hours shall not be considered an increase in pay, and that the new hourly rates will be adjusted upward accordingly on the basis of the 40-hour week." The convention also decided to leave the matter of the gradual elimination of helpers to the individual shop crafts. Jurisdictional disputes will in the future be decided either by the organizations on the railroad involved, or by agreement between the respective international unions.

The delegates at the convention planned to further the election of candidates for political offices who are known to favor an eight-hour law for workers in all industries. Burt M. Jewell, president, and James M. Burns, secretary-treasurer, were unanimously reelected by the meeting.

Division 4, American Federation of Labor, meeting at Winnipeg, Man., June 2, adopted resolutions similar in intent to those drafted at the Chicago meeting. The program, which the Canadian shop crafts will endeavor to get adopted, includes the 40-hour week, with no reduction in wages, a reduction of the number of apprentices and lengthening of their period of apprenticeship, the gradual elimination of helpers, two weeks' holiday with pay, employment of a minimum force for at least one year and the establishment of a reserve of shop work to provide employment for a minimum force during periods of depression.

Domestic Orders Reported During June and July, 1930

Locomotives

July

Name of Company	No. locos. ordered	Type	Builder
Aluminum Company of America	1	Switching	Baldwin Loco. Wks.
Salt Lake & Utah	1	Electric Freight	Westinghouse Electric & Mfg. Co., and Baldwin Loco. Wks.
Total for the month	2		

Freight Cars

June

Name of Company	No. cars ordered	Type	Builder
Lehigh Navigation Coal Company	7	Dump	Magor Car Corporation
Waugh Brothers, Inc.	10	Dump	Koppel Industrial Car & Equipment Co.
Duquesne Slag Products Company	1	Dump	Koppel Industrial Car & Equipment Co.
Union Pacific	20	Ore	St. Louis Car Company
Westinghouse Electric & Mfg. Company	6	Dump	Koppel Industrial Car & Equipment Co.
Erie	50	Gondola	Pressed Steel Car Company
North Western Refrigerator Line Company	50	Refrigerator	Company Shops
Erie	150	Ballast	American Car & Foundry Company
Norfolk & Western	500	Box	Company Shops
Total for the month	794		

July

Electro Metallurgical Company	1	Hopper	American Car & Fdy. Co.
American Agricultural Chemical Company	3	Tank	General American Tank Car Corp.
Western Electric	10	Flat	Koppel Industrial Car & Equipment Co.
Chicago & North Western	10	Flat	American Car & Fdy. Co.
Fruit Growers Express Co.	154	Refrigerator	Company Shops
Missouri-Kansas-Texas	25	Caboose	Company Shops
Detroit Edison Company	5	Hopper	American Car & Fdry. Co.
Gulf Refining Co.	125	Tank	General American Tank Car Corp.
	125	Tank	Petroleum Iron Works
Western Fruit Express	12	Refrigerator	Company Shops
United States Navy Department, Bureau of Supplies and Accounts	2	Box	American Car & Fdy. Co.
	2	Flat	
National Dump Car Company	10	Dump	American Car & Fdy. Co.
Delaware, Lackawanna & Western	25	Gondola	Magor Car Corp.
Minneapolis & St. Louis	500	Box	General American Car Co.
Aluminum Company of America	20	Hopper	Canton Car Company
	25	Hopper	
Viscose Company	2	Flat	Pressed Steel Car Co.
Gulf Refining Company	125	Tank	Petroleum Iron Works
	125	Tank	General American Tank Car Corp.
Total for the month	1306		

Passenger Cars

June

Name of Company	No. cars ordered	Type	Builder
Missouri-Kansas-Texas	3	Dining	American Car & Fdy. Co.
Erie	3	Dining	Pullman Car & Mfg. Corp.
Boston & Maine	4	Dining	Pullman Car & Mfg. Corp.
Erie	3	Combination Mail and Exp.	American Car & Fdy. Co.
Total for the month	13		

July

Union Pacific	14	Chair	Pullman Car & Mfg. Corp.
	10	Baggage	Pressed Steel Car Co.
	1	Baggage-Mail	Pressed Steel Car Co.
Erie	7	Coach	Pullman Car & Mfg. Corp.
Total for the month	32		

Supply Trade Notes

THE NATIONAL BEARING METALS CORPORATION, St. Louis, Mo., has recently acquired a new plant at St. Paul, Minn.

THE KLASING CAR BRAKE COMPANY has moved its office to the Southmoor Hotel, 6646 Stony Island avenue, Chicago.

H. D. CARLTON has resigned as president of the Consolidated Ashcroft Hancock Company, and as vice-president of Manning, Maxwell & Moore, Inc.

GEORGE E. WATTS, Atlanta, Ga., has been appointed sales representative of the J. S. Coffin, Jr., Company, Englewood, N. J.

WILLIAM R. BURROWS, vice-president of the General Electric Company, succeeds vice-president Cummings C. Chesney as chairman of the manufacturing committee of that company.

THE PREST-O-LITE COMPANY, INC., New York, has opened a new plant for the manufacture of dissolved acetylene at 1240 Stewart avenue, S. W. Atlanta, Ga., and the old plant at 345 Kuhrt street, Atlanta, has been discontinued.

WILLIAM HILDEBRAND, traffic manager of the Thomas A. Edison Industries, Inc., West Orange, N. J., has been elected a vice-president of that corporation.

THE LINCOLN ELECTRIC COMPANY, Cleveland, Ohio, has moved its Baltimore, Md., distributor's office from 432 North Calvert street to 600 North Calvert street. T. A. Canty is in charge of distribution in this territory.

R. L. HERMANN, transportation manager of the Southwestern district of the Westinghouse Electric & Manufacturing Company has been appointed heavy-traction representative with headquarters at New York.

THE OHIO BRASS COMPANY, Mansfield, Ohio, has moved its Philadelphia, Pa., offices from the Packard building to Room 1164 Broad Street Station Building, 1617 Pennsylvania boulevard. The telephone numbers remain the same as in the former offices.

H. H. PEASANCE, formerly general sales manager of the steel bar division of the Bourne-Fuller Company, Cleveland, Ohio, has been appointed district sales manager of the Republic Steel Corporation, Youngstown, Ohio, with headquarters at Indianapolis, Ind.

A. W. CLOKEY, railroad sales representative of the American Arch Company, has resigned to become railroad sales representative of the Joslyn Manufacturing & Supply Company, with headquarters at 120 South LaSalle street, Chicago.

THE RAWLPLUG COMPANY, INC., has moved its office to 92-98 Lafayette street, New York.

FRANK DUSTAN, formerly in the engineering department of the Putnam Machine Works, has been appointed chief engineer of the Putnam plant of Manning, Maxwell & Moore, Inc.

THE INDEPENDENT PNEUMATIC TOOL COMPANY, Chicago, has purchased the Cochise Rock Drill Manufacturing Company, Los Angeles, Cal., which will be operated by the former company as a unit of its organization, with no change in personnel.

C. H. ARMSTRONG, formerly director of trade expansion of the Textile Bag Manufacturer's Association, has been appointed general manager of the Clegg Lock Washer Company, Chicago, and will have complete charge of production, marketing and administration.

J. F. RAPS, general locomotive and boiler inspector of the Illinois Central, has resigned to become central manager of the Okadee Company and the Viloco Railway Equipment Company, with headquarters at Chicago. Mr. Raps entered railroad service as a special apprentice in June, 1900, with the Burlington, Cedar Rapids & Northern (now a part of the

John F. Raps

Chicago, Rock Island & Pacific). In July, 1904, he resigned to accept a position with the Toledo, St. Louis & Western at Frankfort, Ind., and in April, 1905, entered the employ of the Illinois Central at Waterloo, Iowa. In April, 1909, he was promoted to general locomotive inspector with headquarters at Chicago.

THE VALSPAR CORPORATION, New York, has merged the Detroit Graphite Company, Detroit, Mich., and the Dominion Paint Works, Ltd., Walkerville, Ontario, with its existing units. The plans for consolidating the activities of the two companies with the other units of the Valspar Corporation do not contemplate any change in management or loss of identity in these two new subsidiaries.

D. P. MORGAN, who has been connected with the Philadelphia branch of the Gustin-Bacon Manufacturing Company for the past eleven years, has resigned to become railroad representative of the Garlock Packing Company, with headquarters at 1211 Arch street, Philadelphia, Pa. Mr. Morgan will cover southeastern territory.

JAMES R. WHITE, secretary of Jenkins Bros., New York, has been promoted

James R. White

to vice-president and director of sales of the company, with headquarters at New York.

W. L. LEWIS, formerly assistant comptroller of the Bethlehem Steel Corporation, has been elected vice-president, secretary and treasurer of the Chicago Pneumatic Tool Company, New York, succeeding J. G. Grimshaw, secretary and treasurer, resigned.

G. F. BLACKMER, general superintendent, and J. A. Coakley, general traffic manager of the American Steel & Wire Company, have been appointed vice-presidents, with headquarters at Cleveland, Ohio. B. H. Lawrence, mechanical engineer, has been promoted to chief engineer at Cleveland. Frank Baaches, vice-president at Chicago, has been appointed assistant to the president.

WILLIAM STRINGHAM, assistant general superintendent of the East Works plant of the American Rolling Mill Company, Middletown, Ohio, since 1923, has been appointed assistant vice-president of the company. Mr. Stringham joined the American Rolling Mill Company on February 18, 1901, as a roller in the Central Works plant at Middletown. He continued as a roller until January 1, 1912, when he was appointed assistant superintendent of the sheet and jobbing mill. On June 1, 1922, he became superintendent of the sheet and jobbing mill departments, and on February 1, 1923, was promoted to the position of assistant general superintendent of the East Works. He is now in charge of all the rolling and finishing operations at that plant.

THE INDEPENDENT PNEUMATIC TOOL COMPANY, Chicago, has opened a branch sales office at 6200 East Alauson Avenue, Los Angeles, Calif., in charge of Vernon Job who was formerly manager of the San Francisco office. Mr. Job will be assisted by B. J. Herron.

HAYDEN B. RUSSELL has been appointed sales representative of the Modern Tool Works Division of the Consolidated Machine Tool Corporation of America, Rochester, N. Y. Mr. Russell will cover the Metropolitan district, his headquarters being at 150 Broadway, New York.

C. B. WOODWORTH, manager of the western division of the Vanadium Corporation of America, has been appointed manager of the railroad division of the corporation, and Walter Smith has been appointed assistant manager of the railroad division, both with headquarters in the Straus building, Chicago. Mr. Smith is a graduate in mechanical engineering, Cornell University, 1909, and is a member of the American Society of Mechanical Engineers. He entered railway service with the Chicago, Rock Island & Pacific and subsequently served the Baltimore & Ohio and the Chicago & North

W. Smith

Western in various supervisory capacities. In 1916, he entered the service of the Pyle-National Company, Chicago, leaving this company for service in the A.E.F. where he was connected with the P.L. & M. shops and regimental camp at Nevers, France. After the Armistice he was associated with the Inter-Allied Railroad Commission and supervised the transfer of cars and locomotives in Germany in accordance with reparations agreements. Upon his return to this country, Mr. Smith resumed his service with the Pyle-National Company as special representative on sales and service work.

BULLARD-DAVIS, INC., a subsidiary of the Davis Emergency Equipment Company, New York, manufacturers and distributors of first aid and safety equipment has formed a wholly-owned subsidiary, the Davis Emergency Equipment Company, Ltd. The newly organized company will be the exclusive sales representative for Davis products in 11 western states. Its offices, to be located at 1268 Mission street, San Francisco, Cal., will be under the management of Herbert Brendlen, formerly New Jersey sales representative of Bullard-Davis, Inc. Other changes in the Bullard-Davis sales organization include the appointments of L. S. Johnston as sales representative in the Boston, Mass., territory; of Daryl Potter as a member of the San Francisco sales force; of H. C. Weigley and J. B. Blakemore as manager and assistant manager, respectively, of the Houston, Tex., sales office; of H. J. Elwood as sales representative in northern and western New York state, with headquarters at Buffalo, N. Y., and of L. W. Brendlen as sales representative in the New Jersey territory.

W. E. COLLIER, formerly district sales manager for the Republic Iron & Steel Company, has been appointed district sales manager of the Republic Steel Corporation, with headquarters at Cleveland. S. L. Gibbons, formerly sales manager for the Central Alloy Steel Corporation, has been appointed assistant district sales manager of the Republic Steel Corporation, with headquarters at Cleveland. W. H. Oliver, formerly district sales manager for the Republic Iron & Steel Company, has been appointed district sales manager for the new corporation. T. B. Davies, former sales-manager of the Central Alloy Steel Corporation, with headquarters at Syracuse, N. Y., has been appointed district sales manager, with headquarters at Buffalo. R. V. Jones, formerly district sales manager of Republic, has been appointed district sales manager at Buffalo. William Vosmer, formerly vice-president in charge of sales of the Donner Steel Company, has been appointed sales manager of the bar division of the Republic Steel Corporation, with headquarters at Youngstown, Ohio. L. D. Mercer, formerly in charge of the sheet sales of the Central Alloy Steel Company, has been appointed sales manager of the sheet division.

Obituary

ELMER A. SPERRY, engineer and inventor, died on June 16 at St. John's Hospital, Brooklyn, N. Y., from complications which set in after he had recovered from an operation six weeks ago. He was in his seventieth year.

Mr. Sperry was born at Cortland, N. Y., October 12, 1860, and was educated at the State Normal School in that city. He subsequently attended Cornell University for one year but most of his training along the lines in which he specialized in his later life came from his own study and research. In 1879, when he was not yet 20 years of age, he perfected one of the first electric arc lights in America. In the following year he founded the Sperry Electric Company of Chicago for the manufacture of arc lamps, dynamos, motors and other electrical appliances. He also established the Sperry Electric Railway Company of Cleveland, Ohio, for the manufacture of cars, and in 1894, he sold this company to the General Electric Company of New York. His work from that time on included improvements in mining machinery, electrical equipment, street railway cars, inventions in the field of electro-chemistry and the practical application of the gyroscope to steamships. Previous to 1910 six large industrial cor-

Elmer A. Sperry

porations had been founded to manufacture Mr. Sperry's inventions. Since that time his fields of endeavor have been broadened still further, to include many devices used by navies throughout the world, as well as in aircraft and marine work in general. The Sperry gyroscope for stabilizing ships and airplanes, the gyro-compass, drift indicators, gun-fire control apparatus, bomb sighting devices and other appliances for which more than 400 patents have been granted, placed Mr. Sperry in the foremost rank of engineering progress. In January, 1929, he sold the Sperry Gyroscope Company, of which he had been president since 1910, to the North American Aviation Company, and soon after that started building up the Sperry Development Company, Inc., and the Sperry Rail Service Corporation. In 1930, he organized Sperry Products, Inc., as successor to the two last-named companies. In the early part of this year, Mr. Sperry was awarded the American Iron and Steel Institute medal for his work in connection with the development of the Sperry transverse fissure detector car, adopted by the American Railway Association and used by a number of railroads for the detection of transverse fissures in steel rails.

Mr. Sperry was a member and co-founder of the American Institute of Electrical Engineers and American Electro-chemical Society, a member and president (1928) of the American Society of Mechanical Engineers, and a member of the American Chemical Society, the Society of Naval Architects and Marine Engineers, Society of Automotive Engineers, American Physical Society, American Academy of Arts and Sciences, National Aeronautics Association, National Academy of Science and a number of other scientific organizations. In addition to the Iron and Steel Institute medal mentioned above, he

was also the recipient of the Franklin medal, 1914; grand prize for gyro-compasses and gyroscopes, San Francisco Exposition, 1915; Collier Trophy for drift set, 1916; Scientific American Medal, and the American Museum of Safety and John Fritz Medals. He went in 1929 as head of the United States delegation to the World Engineering Congress in Tokio, Japan.

JOHN M. CALLEN, for a number of years vice-president and a director of the Reading Iron Company and the Thomas Iron Company, Reading, Pa., died on July 2 at the Reading hospital following an operation for appendicitis. Mr. Callen was 73 at the time of his death. In his early business career he was employed by the Pottsville Iron & Steel Company. In July, 1899, he went to the Reading Iron Company where he served successively as auditor, purchasing agent, assistant general manager and vice-president, having for several years had supervision of purchases, distribution of materials as well as contracts.

WILLIAM HEAWORD WOOD, a mechanical engineer and designer and builder of special hydraulic machinery, with offices at Media, Pa., died at his home on July 12. Mr. Wood was born on November 26, 1844, at Stockport, England. He received his education at Stockport and

W. H. Wood

Derbyshire, England, and on coming to this country located at 176 Broadway, New York, where he became associated with the late Thomas Shipley, former president of the York Ice Machinery Company, in a partnership which was dissolved in 1886. While in New York he took out patents for some of the first refrigerating and ice machinery in this country, the machinery being made by B. W. Payne & Sons, Elmira, N. Y. During the period from 1886 to 1891 he was associated with Bement, Miles & Co., Philadelphia, and in 1892 he established his own business at Media, in which he continued until February of this year when he sold his hydraulic business to the Reading Iron Company, Reading, Pa. Mr. Wood was the designer of the corrugated locomotive firebox placed in operation in 1908.

Personal Mention

General

H. W. PINKERTON has been appointed electrical and mechanical engineer of the Cleveland Union Terminal.

R. F. THOMAS has been appointed traveling engineer of the Canadian Pacific, with headquarters at Montreal, Que.

A. H. WILLIAMS, supervisor of apprentices, Western Region, of the Canadian National at Winnipeg, Man., has been transferred to Montreal, Que., as general supervisor of apprentice training for the system. Mr. Williams will report to John Roberts, general supervisor of shop methods.

Master Mechanics and Road Foremen

R. G. MCKEE, master mechanic of the Chesapeake & Ohio at Peru, Ind., has been transferred to Russell, Ky., succeeding C. B. Hitch as master mechanic of the Cincinnati and Russell divisions.

E. F. STROEH, mechanical superintendent of the Missouri Pacific at St. Louis, Mo., has been appointed master mechanic of the Missouri and Illinois divisions, with headquarters at Poplar Bluff, Mo., and the position of mechanical superintendent has been abolished.

E. A. GILBERT, general master car repairer of the Southern Pacific, Pacific Lines, with headquarters at San Francisco, Cal., retired from active service on June 30. Mr. Gilbert first entered the service of the Southern Pacific as a car inspector at Sacramento, Cal., in 1887. In 1903 he resigned to accept a position with W. H. Miner in Chicago. He returned to the Southern Pacific in 1912 as a general inspector in the motive power department and was later promoted to the position of general master car repairer.

THROUGH A REORGANIZATION which is being undertaken in the supervisory positions on the National of Mexico, the following officers, who held the titles of assistant superintendent on the divisions indicated, have been transferred to the mechanical department: M. Santa, Chihuahua division; L. Veron, Torreon division; J. M. Borrego, Durango division; P. Ortegon, Monclova division; F. C. Rosales, Norte division; V. Garza, Golfo division; A. Garduno C., Cardenas division; R. Fernandez, San Luis division; E. King, Aquascalientes division; S. Aginlar, Guadalajara division; A. C. Ravelo, Pacific Division; A. Prince and M. C. Abasta, Mexico-Queretaro division; D. Encinas, National of Tehuantepec and Pan-American divisions; E. R. Huerta, Puebla division; V. I. Mayme, Jalapa division, and I. R. Canedo, Oaxaca division. Most of these officers have been appointed road foremen of engines.

Car Department

H. E. MYERS, master mechanic of the Lehigh Valley, has been appointed master car builder, with headquarters at Bethlehem, Pa.

ROY E. BAKER, who has been appointed general air brake inspector of the Boston & Maine, with headquarters at Boston, Mass., was born on February 20, 1901,

R. E. Baker

at Meyersdale, Pa. He is a graduate of the Pennsylvania State College, class of 1923. For two years he was in the employ of the Union Switch & Signal Company and on June 16, 1925, entered the service of the Boston & Maine.

Shops and Enginehouse

EARL W. MOORE has been appointed assistant foreman in the erecting shop of the Maine Central at Waterville, Me.

H. A. SOUTHWORTH, general foreman of the Maine Central at Rigby, Me., has been appointed foreman at Vanceboro, Me.

F. W. RICHARDSON, a foreman of the Maine Central at Bangor, Me., has been promoted to the position of general foreman, with headquarters at Rigby, Me.

J. F. MCWILLIAMS, assistant general foreman of the Maine Central at Rigby, Me., has been promoted to the position of foreman, with headquarters at Waterville, Me.

W. C. LUNT, assistant foreman at the Waterville, Me., shops of the Maine Central, has been promoted to the position of day foreman at the Bangor, Me., enginehouse.

H. E. MAY has been appointed general locomotive and boiler inspector of the Illinois Central, with headquarters at Chicago, succeeding J. F. Raps, resigned.

T. J. HOBBS, enginehouse foreman of the Central of Georgia at Macon, Ga.,

has been appointed general foreman in charge of the Cedartown shops, succeeding W. W. Boulineau, retired.

G. A. RHOADS, master mechanic of the former Allegheny division of the Pennsylvania at Oil City, Pa., has been appointed general foreman on the Buffalo division.

C. W. PARSONS has been appointed machine and gang foreman of the Oregon-Washington Railroad & Navigation unit of the Union Pacific System, with headquarters at LaGrande, Ore.

GEORGE POWELL has been appointed mechanical foreman of the Oregon-Washington Railroad & Navigation Company, with headquarters at Baker, Ore.

Purchases and Stores

F. G. MURRAY has been appointed storekeeper of the Louisiana & Arkansas Lines with headquarters at Minden.

J. S. HAYES has been appointed storekeeper of the Boston & Maine with headquarters at East Deerfield, Mass.

F. W. HOLT, purchaser of the Erie, has been appointed assistant purchasing agent, with headquarters at New York.

F. E. DRISCOLL, purchaser of the Erie, has been appointed purchasing agent, with headquarters at New York.

D. E. CONWAY has been appointed storekeeper of the Boston & Maine with headquarters at Charlestown, Mass.

THE OFFICE OF O. A. DONAGAN, general store keeper of the Boston & Maine, has been transferred from Billerica shops to Boston, Mass.

W. E. RUSTON, assistant general storekeeper of the Boston & Maine at North Billerica, Mass., has been appointed traveling storekeeper, the position of assistant general storekeeper having been abolished.

Obituary

W. R. COLLINS, manager of purchases of the Erie, with headquarters at New York., died at Newark, N. J., on June 28.

JOHN H. LOCK, steel car foreman at the Pittsburg, Kan., shops of the Kansas City Southern, died at his home in Pittsburg, on June 3.

WILLIAM M. GUSTIN, foreman car inspector of the Bangor & Aroostook at Derby, Me., died on July 16 from injuries received in an automobile accident. Mr. Gustin was born on September 18, 1868 at Holden, Me. He entered the employ of the Bangor & Aroostook at Caribou, Me., on February 14, 1895, as a carpenter. For a period of about twelve years, beginning January 12, 1912, he occupied the position of chief car inspector, and for the past six years was located at Derby as foreman car inspector, general repair shop.

Trade Publications

Copies of trade publications described in the column can be obtained by writing to the manufacturers. State the name and number of the bulletin or catalog desired, when mentioned in the description.

WIRE TABLES.—The higher tensile strength standards for Copperweld Wires and strands ar contained in the new data sheet prepared by the Copperweld Steel Company, Glassport, Pa.

ELECTRIC WELDING EQUIPMENT.—Wilson electric welding equipment and welding materials are described in the latest catalogue of the Wilson, Welder & Metals Company, Hoboken, N. J.

NIBBLING MACHINES.—The new catalogue of Andrew C. Campbell, Inc., Bridgeport, Conn., describes the complete line of Campbell nibbling machines and gives a detailed description of how the machines operate.

SPECIALLY ALLOYING ELECTRODES.—The Alloy Welding Processes, Ltd., Forest road, London, E. 17, England, describes in Bulletin No. 16 special alloying electrodes for the welding of corrosion and heat-resisting steels and alloys.

ELECTRIC TOOLS.—The Chicago Pneumatic Tool Company, 6 East Forty-Fourth street, New York, describes in catalog No. 898 its diversified line of portable electric tools which vary from small drills weighing 6¾ lb. to heavy duty reamers weighing 96 lb.

PROMAL.—The Link-Belt Company, 200 South Michigan avenue, Chicago, has issued a chart showing the average yield point, average ultimate strength and Brinell hardness of malleable iron and cast steel as compared with Promal, a new metal for chains which is being manufactured by the company.

CONVERSION FACTORS.—A list of conversion factors is contained in Dabeg bulletin No. 2 which is being issued in English, French or Spanish by the Societe d'Exploitation des Procedes Dabeg, 4, Rue du General-Foy, Paris, 8e. Other papers are available on such specialties as the feedwater heater, economiser, brake slack adjustor and poppet valve gears.

MATERIAL HANDLING. — The Elwell-Parker Electric Company, Cleveland, Ohio, has issued Bulletin No. 8, entitled "Opportunity for Cost Reduction in the Handling of Railroad Stores," which consists of several pages of illustrations of stores handling operations with electric lift trucks and skids, supplemented by text matter to show by time studies how individual operations contrast with previous methods of doing the same work. The report covers the handling of brass, air hose, brake beams, brake shoes, wheels, locomotive tires, etc.

ALLOY STEELS.—"Alloy steels in the Railroad Field" is the title of a 12-page booklet issued by the International Nickel Company, 67 Wall street, New York. The booklet discusses the increase in strength with a decrease in weight attainable by the use of alloy steel for railroad forgings, castings and boiler plate; the comparative physical properties of alloy and carbon steels in such applications; economics of operation; corrosion-resisting materials; nitriding, and miscellaneous metals.

ALUMINUM.—The deviations in design and shop practice which must be observed in order to obtain efficient riveted fastenings are discussed in an attractive booklet, "The Riveting of Aluminum and Its Alloys," issued by the Aluminum Company of America, Pittsburgh, Pa. In a second booklet, "The Welding of Aluminum and Its Alloys," the principles involved in the welding of aluminum and its alloys are briefly discussed and specific instructions for such operations given.

PORTABLE TESTING MACHINES. — The new Southwark-Built Oxweld portable testing machine developed in collaboration with the Union Carbide and Carbon Research Laboratories is described on circular Form No. A-100-10M issued by the Southwark Foundry & Machine Company, 400 Washington avenue, Philadelphia, Pa. The machine is especially adapted for tensile tests of welded joints.

ARMCO.—"A Visit to Armco with the Iron Master" is the title of the romantic stories of a great iron and steel industry which have been prepared in booklet form by the American Rolling Mill Company, Middletown, Ohio. The narrative pictures iron and steel making from the early ages to the present day and contains an illustrated story of a visit to the Armco plant.

LATHES. — The South Bend Lathe Works, South Bend, Ind., has just published Bulletin No. 18, a 16-page booklet in two colors, illustrating, describing and pricing its 1930 New Model 18-in. swing back-geared screw cutting precision lathe with the various assortments of chucks, tools and attachments. An item of special interest is the New Model toolroom precision lathe which is practical for the making of precision master taps, screw gages, special screws, dies, etc.

STEAM AND ELECTRIC LOCOMOTIVE SANDERS.—An eight-page booklet, issued by the Viloco Railway Equipment Company, Chicago, describes the latest Viloco sanders for steam and electric locomotive service. After pointing out that these sanders are the result of sander-building experience extending over nearly a quarter of a century, the booklet illustrates clearly how the sanders are made and operate. Single, double, triple and quadruple-type sanders are shown; also a booster sander, an improved duplex engineers' valve, a sander trap cover, and an automatic rail washer. Line drawings show the application of Viloco sanders to various classes of locomotives.